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The Ethical Dilemma of Science

A. V. HILL

The ethical problems confronting the scientist today were the subject of the Presidential Address given to the British Association at its meeting in Belfast, Ireland, this September by Professor A. V. Hill, noted British scientist and parliamentarian. Professor Hill, holder of the Nobel Prize in physiology, is an Honorary Fellow at University College, University of London. The major portions of his address are given below.

THE Duke of Edinburgh concluded his Presidential Address last year with the words,

"It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive?"

Here was a challenge to his successor: to discuss how far science has already contributed to human betterment, how far it has provided fresh problems, dangers, and difficulties; and to suggest ways in which all who are concerned with science can help, as citizens, to make sure that its results in fact are beneficial.

As citizens: for scientists as such have no title to superior wisdom or virtue, and outside their special knowledge they are just as likely as others to be misled. The fundamental principle of scientific work is unbending integrity of thought, following the evidence of fact wherever it may lead, within the limits of experimental error and honest mistake. On this there can be no compromise. And since science is a universal interest of mankind, recognizing no barriers of race, class, religion, or opinion (provided that is honest), a necessary condition of its advance and application is one of friendliness, frankness, and equality. Goodwill and integrity, therefore, are indispensable alike to scientific progress itself and its successful employment for the benefit of mankind. Those who look to scientists as magicians, able to conjure a universal formula out of a hat, may be disappointed to find only so ancient a doctrine; and admittedly there *is* far more to science than integrity and goodwill. But these are the qualities chiefly required to utilize the opportunities, to resolve the problems and difficulties, which science has provided for present-day society.

Can Science Replace Older Motives of Human Conduct?

The common phrase, "this scientific age," is all too apt to imply, with little justification, that the majority of people, at least in highly developed countries, now think and act scientifically; and, with no justification at all, to suggest that science can replace the older motives of human conduct. It is true that the external circumstances of life have been vastly altered by the applications of scientific discovery and invention, though as yet for only a minority of mankind. The future alone can decide whether natural resources and human ingenuity will prove sufficient, given statesmanship and goodwill, for the same transformation gradually to affect the whole of human society. If not, are stable conditions ultimately possible? Or will there be perpetual conflict between the "haves" and the "have-nots?" It is true also that the methods, ideas, and results of scientific inquiry have penetrated widely, if not deeply, into popular thinking and belief: the jargon at least of science is widespread, and magic and superstition are gradually losing, if not their currency, at least their respectability.

Yet such changes may have little real influence on the basic pattern of human behavior, and if witches are no longer hunted down and killed, political and racial intolerance can lead to even wilder and crueler excesses. In clearing away old idolatries there is always a danger of allowing new ones to creep in: the unclean spirit went out when the house was swept and garnished, but only to return with seven others more wicked than himself.

The improvement of man's estate by the application of scientific knowledge is one of the loftiest of adventures: but a belief that it can be achieved by scientific methods alone, without a moral basis to society, is a perilous illusion. If the methods of human experiment and racial improvement adopted by the Nazis could be regarded purely as applied biology, there might be much to say for them. But most of us believe that by abandoning a faith (which has nothing directly to do with science) in the sanctity of the human individual and of moral law, they were heading straight for disaster. Yet we shall see later the dilemma in which such scruples put us, in respect of the gravest of all world problems.

The conflict between new knowledge and traditional belief is no novelty. When Eve saw that the tree of knowledge was good for food, that it was pleasant to the eyes, and to be desired to make one wise, she took of the fruit thereof and did eat and gave also to Adam and he did eat. Which led, as you have read, to their exclusion from the garden and the warning, "in sorrow shalt thou eat of it all the days of thy life." Again and again the attempt has been made to forbid the fruit of scientific knowledge.

In 1874 in this city John Tyndall delivered a presidential address to the British Association which provoked a hurricane of controversy: the records tell us that it was denounced from every pulpit in Belfast. Yet, reading it now, one is impressed not only by its courage but by its reasonableness. It is true that he claimed that science will wrest from theology the entire domain of cosmological theory, whether of living or of non-living things; but he had previously referred to the immovable basis of the religious

sentiment in human nature, bringing as he said "completeness and dignity to man." The views of Lucretius and Bruno, Darwin and Spencer, might be wrong: whether right or wrong, he insisted, we claim the right to discuss them. If today I claim the right to discuss not only the scientific facts themselves but their consequences in human affairs, I doubt whether denunciation will follow: if it does, I shall be sorry but unrepentant.

The development which has brought most vividly to the public conscience today the ethical problems aroused by the advance of scientific knowledge lies in the field of nuclear physics; and groups of scientific people in the free countries of the world are vigorously debating its various consequences, among them particularly the secrecy attached to weapons as new and devastating as those provided by nuclear fission. Atomic physics, however, is only one of many scientific developments which have brought, or are bringing, a mixture of possible good and evil about which judgments of relative value must be formed: we must not get too excited about one of them. There is no secrecy about most of these developments, they occur gradually and continuously before our eyes, we tend to accept them without question as though they were natural phenomena: yet in fact the consequences of one of them provide the most solemn problem in the world. The dilemma is this. All the impulses of decent humanity, all the dictates of religion, and all the traditions of medicine insist that suffering should be relieved, curable disease cured, preventible disease prevented. The obligation is regarded as unconditional: it is not permitted to argue that the suffering is due to folly, that the children are not wanted, that the patient's family would be happier if he died. All that may be so; but to accept it as a guide to action would lead to a degradation of standards of humanity by which civilization would be permanently and infinitely poorer. Conduct usually falls short of principles: but that would be the worst reason for abandoning principles altogether.

Increasing Population: Its Effect on Resources

In many parts of the world advances in public health, improved sanitation, the avoidance of epidemics, the fighting of insect-borne disease, the lowering of infantile death rates, and a prolongation of the span of life have led to a vast increase of population. Not only is the population increasing, but in many places its rate of increase is still rising: and these processes will take so long to reverse that for many years to come the shortage of natural resources, particularly of food, is bound to provide increasing deprivation and disturbance. That provides the practical motive of the Colombo Plan. In India, a Government Planning Commission in a report of July 1951 entitled "The First Five Year Plan," has dared to face the facts. A doubling in the last thirty years of the survival rate (births minus deaths) has led to a rate of increase of nearly 1½ per cent per annum, a total of 5 millions every year in a population of 360 millions.

> "With all the effort that the First Five-Year Plan will represent, it will be possible barely to restore by 1955–1956 the pre-war standards in regard to food and clothing. Increasing pressure of population on natural resources retards economic progress and limits seriously the rate of extension of social services so essential to civilized existence."

The pre-war standard in fact was miserably poor, a large part of the population existed below the level of a decent life, scores of millions only just above that of famine. Yet the gigantic national effort proposed in the Five Year Plan, even if successful, may only just restore that miserable standard. Can it sustain it then if the rate of population increase continues? It is easy to answer that a higher standard of life has led in other countries to a gradually falling birth rate: but a higher standard requires a far greater charge on natural resources of all kinds, which cannot be met until the pressure of population is reduced.

In the meantime there is more than danger that the emergency will result in an overuse of natural resources, leading by land erosion, deforestation, and other factors to permanent and irretrievable loss: this has happened already, and is visibly happening now, in many parts of the world. In a special section on "Family Planning" the Indian Report recognizes that "an alteration in population trends takes at least a few generations to materialize;" and steps are suggested for the education of public opinion on the need for limitation, and for experimental efforts to be made in the application of simple methods of birth control. For its wisdom and courage in acknowledging the gravity of the situation the Indian Planning Commission deserves every support. But the problem itself has not begun to be solved, and its consequences will dominate the development of India for many years; indeed, its gravity will continue to increase. Malaria is admitted by the Planning Commission to take an annual toll of a million lives, tuberculosis of half a million. The resolute use of insecticides and anti-malarial drugs could soon reduce the former to a small fraction: tuberculosis is bound to require more effort and a longer term. Nobody would dare to say that steps to combat these diseases, and others such as cholera, to improve rural and industrial health, to increase the supply of drugs and medical equipment and services, should not

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"An Art Damageable and Destructive"

". . . But, since then, one day meditating to myself, it had seemed that it was a thing blameworthy, shameful and barbarous, worthy of severe punishment before God and man, to wish to bring to perfection an art damageable to one's neighbour and destructive to the human race, and especially to Christian men in the continual wars that they wage on one another. Consequently, not only did I altogether neglect the study of this matter and turned to others, but I even tore up and burnt everything which I had calculated and written on the subject, ashamed and full of remorse for the time I had spent on it, and well decided never to communicate in writing that which against my will had remained in my memory, either to please a friend or in teaching of these matters which are a grave sin, and shipwreck of the soul. . . ."

—Niccolò Tartaglia
1500?–1557

be taken on the highest priority: but the consequence must be faced that a further increase of a million people per annum would result. Thus science —biological, medical, chemical, and engineering—applied for motives of decent humanity entirely beyond reproach with no objectionable secrecy has led to a problem of the utmost public gravity which will require all the resources of science, humanity, and statesmanship for its solution.

The example of India has been taken because of the sheer magnitude of the problem and because its seriousness is now admitted by humane and responsible men: but the same conditions exist already in many parts of the world and will soon exist elsewhere. It is *not* a question only of food: if a higher standard of life is to become universal, with education, communications, housing, reasonable amenities, and public health, a far greater demand will be made on all such natural resources as power, chemicals, minerals, metals, water, and wood. One is left wondering how long these can possibly take the strain. Could world supplies conceivably hold out if the present requirement per head, in the United States, were multiplied in proportion to meet the same demand everywhere—even without any increase of present population; and if so, for how long? There is much discussion of human rights. At what level can these be reasonably pitched? And do they extend to unlimited reproduction, with a consequent obligation falling on those more careful? These problems must be faced not only with goodwill and humanity, but also with integrity and courage, not refusing to recognize the compulsion of simple arithmetic. It is right that the scientific imagination should be allowed to play sometimes with the more distant future, when possibly new methods and resources may be found to solve all problems; but only on condition that our minds are not deflected from the urgent realities of the present.

Is Applied Science Our Enemy?

By vast improvements in communications, which have made the world so small, applied science has been one of the chief agents in the present ferment of social, political, and economic thought. Can one urge, after the event, that the application was a mistake and that the majority of mankind could better have remained isolated and in ignorance? By making world war technically possible, applied science has helped to stir up national ambitions and social revolutions which, if poverty and deficiency continue without hope, may lead to major world catastrophe. Should we therefore refuse to employ science in defense of liberty and resign ourselves to a universal police state where no scruples are permitted? Are we, in scientific research, to say that some subjects may be investigated, but not others for fear of the consequences? Who then is to decide and by what international authority? And is it practical to insist that all scientific knowledge should be fully and openly disclosed, without secrecy or reservation of any kind, military or industrial? These are problems which cannot be solved by rhetoric, or by any simple formula. The purpose of setting them out is to make clear that we must face them with honesty and courage; for they will not solve themselves.

The Dilemma

I have led you to the ethical dilemma which perplexes many of us by taking an example in which few would question either the motives of those who made the original discoveries or the humanity of their application: indeed, an example in which few could wish that the fruit of the tree of knowledge had been left untried. It is easy to say now that side by side with the control of disease there should have been an equal and parallel effort in education, particularly the education of women as responsible citizens: for there is no possibility, if women remain ignorant and illiterate, of intelligent widespread family planning and control. But education alone would not have been enough, or indeed possible itself without a substantial measure of material and social betterment: and the expense and effort involved in this would have been indefinitely greater than in the application of medicine and hygiene, which after all has been relatively cheap. Had it been possible to foresee the enormous success of this application, would humane people have agreed that it could better have been held back, to keep in step with other parallel progress, so that development could be planned and orderly? Some might say yes, taking the purely biological view that if men will breed like rabbits they must be allowed to die like rabbits, until gradually improving education and the demand for a higher standard of life teach them better. Most people would still say no. But suppose it were certain now that the pressure of increasing population, uncontrolled by disease, would lead not only to widespread exhaustion of the soil and of other capital resources but also to continuing and increasing international tension and disorder, making it hard for civilization itself to survive. Would the majority of humane and reasonable people then change their minds? If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the forseeable consequence is evil?

I remember asking an eminent Indian who had taken part in drawing up the so-called Bombay Plan of 1944 why there was no mention of the gravest problem of all, overgrowing population: he replied that his colleagues and he had indeed discussed it, but decided to leave it to God. To a biologist aware of the methods by which animal population is in fact controlled by nature, this seemed pretty poor comfort: yet there are many who really take that view, admittedly with the element of reason that we never can be sure that things may not turn up to make all our calculations wrong. Should we then just continue to do the good we see in front of us, in confidence that if our motives are humane, good and not evil will finally result? Or, taking that rather easy course, are we not showing a lack of the fundamental virtues of courage and integrity?

Can the Dilemma Be Resolved?

The dilemma is a real one, and cannot be resolved by any simple expedient. In another form it is perplexing many of those who are concerned with the development of nuclear physics, the ultimate service of which may be very great, possibly essential if our present type of civilization is to continue when other sources of power dry up; while the benefits to medicine and industry are already substantial. *But*—nuclear fission has released the threat of unprecedented violence, with the possible destruction of many millions of lives and the accumulated treasures, moral and material, of civilization. The individual conscience may tell a man to have no part in it. That is easy enough, for there are plenty of other interesting things to do, but it does *not* solve the problem. Moreover, it is possible that defensive weapons, based on nuclear fission, but not of the type intended for mass destruction, can be developed which would make armed aggression intolerably costly. What then

of the abolition of secrecy? In principle, yes, for the historic and unique contribution of science to international goodwill has been in sharing knowledge regardless of race and frontier, and the chief satisfaction of scientific work, the condition of its fruitful development, is frank and free discussion. "Cast thy bread upon the waters, for thou shalt find it after many days," is wise and acceptable counsel in dealing with scientific knowledge: while "he that observeth the wind shall not sow and he that regardeth the clouds shall not reap" is as aptly applied to human relations as to agriculture. Every possible endeavor, therefore, should be made toward international agreement on sharing scientific and technical knowledge and controlling nuclear weapons: but this, like peace itself, is a concern of every citizen, not only of scientific people. It is hard enough to get international agreement in quite simple matters, such as the perilous state of the north European fisheries, where no secrecy is involved and little national prestige, and the scientific evidence is unequivocal: but we must go on trying.

Much scientific and technical advance has led to unexpected dangers and difficulties. Without our present knowledge of bacteriology and preventive medicine, gigantic armies could never be kept in the field, and land war on the recent scale would be impossible. Is medical science, therefore, to be blamed for twentieth-century war? The indiscriminate use of insecticides, by upsetting the balance of nature, can quickly do more harm than good. Radio communication may be used for spreading lies and disorder as well as truth and goodwill. Developments in microbiology, in many ways beneficent, may be used in the future for biological warfare, with effects at present unpredictable; and control by international agreement and inspection might be very difficult. The list need not be multiplied; all are aware that every new benefit to mankind provides also its own dangers, either as unexpected consequences or by deliberate misuse. Science is not alone in this: liberty may lead to license, religion can be used to inflame passions, laws can be exploited to protect wrongdoing. If scientists feel called upon to examine their consciences, so much the better: but they need not imagine that in this they are exceptional!

It has been debated whether "the scientific mind is fundamentally amoral." The real answer is that there is no such a thing as "*the* scientific mind." Scientists for the most part are quite ordinary folk. In their particular scientific jobs they have developed a habit of critical examination, but this does not save them from wishful thinking in ordinary affairs, or sometimes even from misrepresentation and falsehood when their emotions or prejudices are strongly enough moved. Their minds are no more amoral than those of surgeons, lawyers, or scholars. As investigators most of them realize that their function would be stultified were they to introduce moral data into a scientific argument. A surgeon is not required, or indeed allowed, to consider whether it woud be better for the world if his patient died under the operation; he has only to carry it out with skill, care, and integrity: but it would be foolish to conclude that the surgical mind is amoral. The surgeon himself, as a human being, has to make moral judgments: but he does so outside the operating theater. So it

is with scientific people. Like all good citizens they must take account of ethical considerations, and the chief of these—as with other good citizens—are of integrity, courage, and goodwill. Integrity forbids them to allow feelings of any kind to obscure facts, but that does not make them amoral: after all, integrity is the first condition of morality.

Freedom of Science Dependent on Scientists Themselves

In the practical world of today, complete abandonment of secrecy, in government and industry, is out of the question. The advantages to international relations, and to general scientific progress, of the greatest possible freedom are evident; to these can be added the impossibility, in a free democracy, of keeping the best people unless the conditions of their work are congenial. If scientific men consistently avoid jobs which seem to them to fall short of reasonable freedom, they will force changes of organization so that only necessary secrecy is maintained. The penalty of filling an organization, governmental or industrial, with second-rate people, cheerfully amenable to unnecessary restrictions, is far too evident in its result on efficiency to be tolerable for long. The cure, therefore, is largely in scientists' own hands. In this, as in many other aspects of their work, moral considerations come in, and the only way to resolve the dilemma which is in so many minds is to discuss it frankly. To neglect it altogether is not amoral but immoral. It is the duty of all of us as citizens to consider the ethical basis of our work.

Today when the public importance of science and its popular esteem may turn some people's heads it is well that scientists should realize that the prestige of science is not their personal property, but a trust which they have an obligation to pass on uncompromised to their successors. The popularizing of genuine science is an important public service; we should all be ready to take our part in it according to our powers: but to use the general prestige of science as a bait to attract attention to pronouncements on other topics, for example on politics or religion, is a disservice both to science and the public. As a citizen I need no more justification than any other citizen in saying what I like about such things: but I have no right to pose as a representative of science in discussing them. In the days when the representatives of religion claimed supernatural knowledge of the natural world it was necessary to insist, as Tyndall did, that the natural world belongs to science. Fortunately those days are past. If they now claim that the facts and trends of overpopulation are not what we say, we can argue about that as a scientific question: but if they insist that its consequences should be left to God, they must allow us as citizens to take the opposite view. If political pressure were applied in any way to force conformity to particular scientific theories, as happened in Germany and is happening now elsewhere, then one's right and indeed one's duty would be clear, alike as citizen and as scientist. But the nature of political institutions and the policies of political parties are not

scientific questions and how I choose to vote has nothing to do with science. Indeed, curious as it may seem, the spectrum of political opinion of scientists in Britain is much the same as that of other similar groups: though the loudspeakers are generally tuned in to one particular wave-band.

Ethical Principles of Science Have Not Yet Clearly Emerged

Some seventeen hundred years ago there crystallized out, from many centuries of experience of the human problems and ethical necessities of medicine, the so-called Hippocratic Oath. The obligation of integrity and trust; the insistent claim of suffering; the care of mothers and children; solicitude for the old and weak; the sanctity of human life: these are as vital a part of medical tradition as its science and its art. Practice, it is true, may lag behind principles, but at least such failure is regarded as discreditable; and it is hard to imagine any kind of civilization in which the ethical principles of medicine were disregarded. That is one reason why the future possibility of biological warfare is particularly repugnant. Today science finds itself, unexpectedly and without those centuries of tradition and experience, in a position no less important to the community than medicine: and its ethical principles have not yet clearly emerged.

Every candidate for admission to the earliest of American learned associations was required to answer yes to the question, "Do you love truth for truth's sake, and will you endeavor impartially to find . . . it for yourself and communicate it to others?" That affirmation might have its place in a modern scientific version of the Hippocratic Oath. But again the same dilemma arises—"endeavor impartially . . . to communicate it to others." Apart altogether from considerations of national security, in many fields today much of the best research is done, and done increasingly, in industrial laboratories. Those who have seen and admired such work, and the people who do it, cannot but applaud the foresight which made it possible. But if all the results are to be communicated at once and impartially to others, could directors and shareholders be reasonably expected to continue their support? Indeed, if an industry were nationalized could it afford to give away its secrets to competitors abroad? Not in any real world in which a nation must remain solvent and industry must depend for success on the rapid application of new knowledge. The dilemma must be met by reasonable compromise, of which, perhaps, the most hopeful sign today is that many of the directors of industry come up through research departments. A friendly and familiar contact between management and research, and between industrial and outside scientists, can reduce this particular dilemma to manageable size.

Scientists' Morals and the Building of Weapons

A graver problem is provided by research under government, when considerations of security come in. In the emergency which became evident in 1935, the secret development of radar for purposes of air defense aroused no obvious pangs of conscience; and many other developments come in that class. But the surest of military maxims is that counter-attack is an essential part of defense; to limit scientific methods to defensive weapons would be to insure defeat, indeed it is quite impracticable. But let us be realists; so long as offensive weapons may be used, the part played by the scientist is no more immoral than that of the engineer, the workman, the soldier, or the statesman, and the attitude of "holier-than-thou" is unbecoming. We all bear, as citizens, an equal responsibility. But is it practical to suggest that all scientists in all countries should agree, and hold to their agreement whatever happens, to take no part in research on offensive weapons, or at least should endeavor impartially to communicate its results to others? The answer is evident. There are individuals in all free countries who find such work intolerable. In those countries their scruples are respected and they are at liberty to do something else; but let them not imagine that the problem is solved that way, or that those who think otherwise are necessarily stupid or immoral. The first condition of freedom is freedom of conscience, and the scientist has the same right to that as any citizen: but freedom does not extend to giving away other people's property, whether of goods or knowledge.

There seems to be no simple answer to the riddle. All knowledge, not only that of the natural world, can be used for evil as well as good: and in all ages there continue to be people who think that its fruit should be forbidden. Does the future welfare, therefore, of mankind depend on a refusal of science and a more intensive study of the Sermon on the Mount? There are others who hold the contrary opinion, that more and more of science and its applications alone can bring prosperity and happiness to men. Both of these extreme views seem to me entirely wrong—though the second is the more perilous, as more likely to be commonly accepted. The so-called conflict between science and religion is usually about words, too often the words of their unbalanced advocates: the reality lies somewhere in between. "Completeness and dignity," to use Tyndall's phrase, are brought to man by three main channels, first by the religious sentiment and its embodiment in ethical principles, second by the influence of what is beautiful in nature, human personality, or art, and third by the pursuit of scientific truth and its resolute use in improving human life. Some suppose that religion and beauty are incompatible: others, that the aesthetic has no relation to the scientific sense. Both seem to me just as mistaken as those who hold that the scientific and the religious spirit are necessarily opposed. Cooperation is required, not conflict: for science can be used to express and apply the principles of ethics, and those principles themselves can guide the behavior of scientific men: while the appreciation of what is good and beautiful can provide to both a vision of encouragement.

Conclusion

Is there really then any special ethical dilemma which we scientific men, as distinct from other people, have to meet? I think not: unless it be to convince ourselves humbly that we are just like others in having moral issues to face. It is true that integrity of thought is the absolute condition of our work, and that judgments of value must never be allowed to deflect our judgments of fact. But in this we are not unique. It is true that scientific research has opened up the possibility of unprecedented good, or unlimited harm, for mankind; but the use that is made of it depends in the end on the moral judgments of the whole community of men. It is totally impossible now to reverse the process of discovery: it will certainly go on. To help to guide its use aright is not a scientific dilemma, but the honorable and compelling duty of a good citizen.

An Interview with Gordon Dean

CHAIRMAN, U.S. ATOMIC ENERGY COMMISSION

The Bulletin *is pleased to be able to give its readers this interview with the Chairman of the U.S. Atomic Energy Commission. Mr. Dean was questioned by Dr. Rabinowitch, editor of the* Bulletin, *and Dr. John Simpson, a member of the Editorial Board.*

QUESTION: Do you think more public discussion and education on atomic energy would benefit the AEC's work?

MR. DEAN: Yes, definitely. And it would be good for the people of this country too.

Q: In what areas do you think public discussion is particularly desirable at the present time?

A: There are a great many, and it would take a good deal of time just to list them. I think, however, they fall into two general categories. One has to do with weapons effects. None of us likes to think that we live in the same world with the atomic bomb, but we do exist in such a world, and we can't make the bomb go away by ignoring it or pretending that it isn't there. What we should do, then, is to make every effort possible to understand the bomb and what it can do. In that way we can learn how to protect ourselves against it and perhaps even find some way to bring it under effective international control. There is a lot of information available on weapons effects, and I think everyone should make a real effort to understand it.

The other general category has to do with the scores of questions related to the peacetime development of atomic energy, which is now getting so far advanced that it has attracted the sincere interest of many private industrial concerns. We are now almost at the time when a good many important questions of public policy must be faced—questions like: "Is the government's monopoly too rigid? Are there perhaps some things that should be taken out of the secret category to speed private participation even though they may also help our international competitors? How large a share of the cost of peacetime development should the government shoulder? Should the government adopt a more liberal policy toward private patent rights?"

The answers to questions like these will influence the course of atomic energy development in this country for many years. They involve every man, woman, and child in this country, and it seems to me that people should be thinking and talking about these things because public opinion in a democracy has a great influence on the actions of government.

Q: What could the *Bulletin of the Atomic Scientists* do in this area?

A: I think you occupy a uniquely favorable position to provide a forum where intelligent and responsible opinion on the various pros and cons of these questions can be exchanged. You have done a lot of this, and I think it has been useful. You might also wish to consider taking a position of your own on some of these questions with the idea of helping to stimulate debate and, therefore, public education. I would hope that, regardless of the position you adopt, you would always provide a sounding board for the opinions of both sides to every question.

The Problem of Scientific Manpower

Q: The AEC is the greatest consumer of scientific and technical manpower in America. Are you anticipating difficulties in the supply of scientists and engineers for the projected increase in the program?

A: Yes, we expect some difficulty, but we don't think the problem is insurmountable and we don't think it will constitute a limiting factor. I say this because our recruitment will be spread over a number of years—years in which the peak demand of the nation's defense production expansion will probably have been passed. We also take comfort from the fact that most of our contractors are of a caliber that will enable them to attract high-grade people. They always have in the past, and we have no reason for suspecting that they won't be equally successful in the future. Don't forget, too, that we have had a training and education program of our own which will serve to increase the size of the reservoir upon which we will draw.

Q: Do you believe that in the present situation basic research at universities must take second place to defense work or do you think it is possible to maintain the highest level of fundamental research?

A: This is a question of balance. Defense work is obviously important, and I am one of those who believe that fundamental research is also of the utmost importance. What we have, then, are two important demands on the talent available, and there is only so much talent to go around. I think it should be shared.

Naturally if we knew a war was going to break out tomorrow, we would do one thing, and if we knew that war would not come for twenty years or would never come at all, we would do another. But we don't know, and so the solution, it seems to me, is to achieve as intelligent a balance as possible.

As a matter of fact, I am greatly disturbed by the view held by many people that fundamental research can wait until the emergency is over. It

can't. These people seem to forget that fundamental research is directly and importantly related to what we call "defense work." It provides the base upon which applied research programs and "defense work" are built. It should never take a back seat to anything, except in those few cases where the conflict is real and the other objectives are immediate and obvious.

Q: Does the AEC believe that fundamental research in its own laboratories is equally as productive as similar research in more academic institutions?

A: There are no easy yardsticks by which one can measure the relative value of different kinds of research. The national laboratories are productive and so are the universities. In my view we need both. I think it should be remembered that much of the research carried on in our laboratories is performed with equipment and facilities that very few, if any, private institutions can finance for themselves.

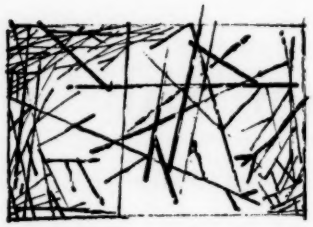
Q: Does the AEC encourage the tendency to attract the best research scientists and projects into the AEC laboratories?

A: I'm interested to hear you say that we have a tendency to attract the best research scientists. I would much rather have that as our problem than to have the problem of not being able to attract the best. But to answer your question: In regard to projects, we sponsor the ones that are of interest to us and don't sponsor the ones that aren't. If the ones we sponsor have a reputation for being the best, that's fine. In regard to people, we naturally try to get the best people we can at the salaries we can offer, and I hope everyone else does the same thing. I would hate to think what would happen to the atomic program if we deliberately set out to staff our laboratories with second-raters.

Effect of Security Restrictions on Research

Q: How does the AEC evaluate the effect of isolation and constant security consciousness on the spirit of free basic research?

A: This is hard to measure, just as it is difficult to measure the effect of the many other intangibles that influence the quality of research. In general, I would say that of course secrecy and isolation have an adverse effect upon the productivity of research, but the Commission makes what I consider to be an honest effort to keep the trappings of security out of those areas where they serve no real purpose—and this includes a large part of what we generally refer to as "basic research." As you know, there is a great deal of research, and particularly basic research, which is out in the open where it can be conducted and talked about freely among the scientific community.



This whole question of secrecy is a very difficult one, and it is one area where public discussion by people with responsible views could serve a useful purpose, particularly if some specific examples of what could be accomplished through modification of the secrecy regulations could be brought forward. Our objective in this, as it is with so many other things we do, is to achieve an intelligent balance —to keep secret those things which through publication would help a potential enemy more than they would help us, and to publish freely those things which, if out in the open, would help us more than they would help a potential enemy. This is a hard goal to achieve, but it is the one we are striving for, and any help that we can get from the scientific community and from industry would be very much appreciated. As you know, we have had a lot of outside help already through various advisory committees.

The AEC and the National Science Foundation

Q: Does the AEC consider rapid development of the National Science Foundation important from its own point of view?

A: Most certainly. We favored its establishment and we favor its continued growth and development. It has an extremely important role to play in the stimulation, encouragement, coordination, and sponsorship of basic research and the more general types of applied research in this country. As you know, the Foundation has taken over the sponsorship of our fellowship programs in physics, and biology and medicine, as it should. I hope it will continue to grow because it has a very important role to play in the scientific life of this country. We shall do everything we can to help it.

Participation of Private Industry in AEC Programs

Q: You have said that release of more information would lead to more participation of private industry in the atomic energy program. Could you enlarge on what areas of information you have in mind and what kind of enlarged industrial participation you anticipate?

A: The kind of industrial participation I had in mind was the kind that industry would undertake with its own money and at its own risk. This involves two things: it involves the performance by industry on a lump sum or fixed basis of some of the manufacturing functions now performed under cost-plus-a-fixed-fee contracts (an example of this is the manufacture of zirconium), and it also involves the development and construction of such facilities as power reactors by industry with its own money.

It is obvious, I think, that industry needs enough information of a technical nature to permit it to know how to undertake this kind of thing, and it needs enough information of a cost nature to enable it to evaluate the risk involved. As you know, a good deal of the basic technological information in the reactor field has fairly recently been placed in the public domain, and I think this has been a very great value to industry, particularly in the training of technical people. We have, of course, not been able to release all of the information that might be useful, but we have taken steps to see that industry has been able to gain access to this information through the device of clearing representatives of industrial study groups. Up until now this device has worked well, and I don't believe industry's progress has been held up at all. But we are rapidly getting to the point where some fundamental decisions on secrecy and a whole range of related problems will probably have to be made. I hope that some intelligent public discussion can be stimulated on these problems for it would be unfortunate, to say the least, if solutions must be sought in a vacuum.

Relations of AEC with Its Contractors

Q: Communist writers, but also many more moderate elements in Europe, believe that the large firms asso-

ciated with the AEC (du Pont, GE, Monsanto) are in fact "running the AEC" and earning big profits. Could you say something about the influence of these firms on the AEC policies, and on their motives for their extensive activities? (The *Bulletin* would like to be able to illuminate the situation particularly for its overseas readers, who are not likely to be satisfied at present with reference to a $1-a-year fee.)

A: I don't believe you will ever change the attitude of communist writers by giving them the facts about any question because they are engaged in a propaganda campaign, not a reasonable discussion. However, for the benefit of more reasonable people, I should like to say as strongly as I know how that our contractors are not "running the AEC," and I am sure these concerns would find it very amusing to learn that they are making big profits.

This is a democracy, and in a democracy no government agency is sensitive to only one segment of the population. We take the views of industry into account, certainly, just as we take into account the views of the scientists, the laboring people, the military men, and the general public whose opinions are ably and consistently brought to our attention through their representatives in Congress. We couldn't survive in this democracy if we did anything else, and that is the way it should be. And of course we must operate always within the framework of the over-all policy laid down to us by the Congress and the President.

As to the motives of our contractors, I believe they vary from company to company. But in every case I believe that the motive of genuine patriotism is strongly present. I am convinced that every company associated with our program is in this business at least partly because it believes its work in atomic energy is of the utmost importance to the security of this country and of the free world. Another motive that I am sure is present in most cases is the "ground floor" motivation—the desire to keep abreast of new developments in a new field that holds tremendous promise for the future. And then there is prestige—the prestige that stems from being connected with a vital enterprise, and from being a pioneer in a promising new industry.

As far as profit is concerned, my experience has been that the main desire of our industrial contractors is that they not lose money because of their participation in this program where there is so little property they can own and so few rights to patents, and so on, that they can enjoy. Many of our contractors do lose money, however, even though their costs are reimbursed and even though they are paid a nominal fee. They lose it because the fee is not large enough to compensate for the profits that their top people could earn for them if they were doing something besides working on a government project. The fees we pay—which, as you know, range down to $1 a year and in some cases no fee at all—are always smaller than the profit almost any of our contractors could realize if they were engaged in a successful private commercial enterprise of their own.

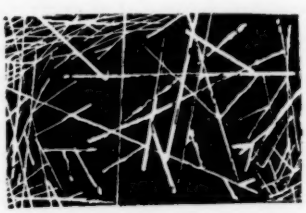
I have heard it said that although our fees range from normal to very small, our contractors who are paid these very small fees actually make a handsome profit out of the overhead payments they receive. These overhead payments are not profit—they are payments for services rendered. They cover such things as the actual expenses incurred by those parts of the company which devote part but not all of their time to AEC work, and by the "home office" organization in carrying out the work imposed on it by the AEC contract. In some cases these overhead payments are negotiated on a basis which we are satisfied is reasonable, and in others they are kept in a separate account, subject to periodic audit, from which any balance remaining at the end of the fiscal year is refunded to the AEC. Last year, under such an arrangement, one company refunded about $5,000,000.

Atomic Power

Q: Are the estimates of the economic aspects of atomic power for industry under continuous study by the AEC?

A: Yes, very serious continuous study.

Q: Are the present estimates, based on plutonium sales to the government, on a fixed price or a "cost plus" basis?



A: We have estimates of all kinds covering every possibility we can think of. At this time it is impossible to say what the best arrangement would be.

Q: Are there any recent estimates of the feasibility of atomic power without such sales for military purposes?

A: Yes, and they are rather encouraging, particularly in the matter of small "power packages" for remote, high-cost power areas. We are looking very closely at this possibility.

Q: Could the enlarged program for AEC development endanger the future use of atomic energy for power purposes by exhausting the more abundant sources of uranium, leaving only economically unrewarding lower-grade sources?

A: Yes, it could, but there are a number of mitigating factors. One is the fact that the world's resources of uranium have not by any means been fully explored. As you know, we are constantly turning up new deposits in our own Colorado Plateau region, and important uranium finds are occurring with increasing frequency in a number of other countries. Then, too, there is the possibility of breeding, which, if successful, will increase our reservoir of fissionable material manyfold. And you must also remember that improvements in uranium extraction and processing and the chemical processing of spent fuel serve to stretch out our supply to a significant degree. I wouldn't write off the fact, either, that all of this material we are now storing in the form of bombs may someday be available for peaceful use.

Q: What is the status of Mr. Putnam's study of energy requirements and resources?

A: It is completed, we have it, and it will be published by a private publisher under contract to us. It is an arrangement similar to the one we used in the case of the *Sourcebook on Atomic Energy*. It should be out in about six months or so.

Q: Could you say something about the present status of the breeding problem?

A: Just a little. As you know, the Experimental Breeder Reactor is now in operation, and we have yet to run across anything which would suggest to us that our attack on this won't be successful. I think it is fair to say that preliminary results seem to bear very favorably upon the future of breeding.

Q: Are the chemical aspects of this program licked, at least in principle?

A: In principle, yes, but certainly not from the economic point of view.

Q: Has the schedule for projected AEC expansion been set?

A: Yes, and we have already started on it.

Q: Can you give us some information on year-by-year goals as planned?

A: I'm afraid not. The year-by-year goals are secret, but I can say that it will take several years to complete this expansion.

The AEC and Civil Defense

Q: Could you say something on AEC cooperation with civil defense authorities?

A: Yes, we work very closely with them. Mainly our efforts are directed toward finding, accumulating, and transferring to the Federal Civil Defense Administration all the information they require from us to carry out their civil defense responsibilities. Much of this is the sort of information we develop at weapons tests. As you know, we published the volume, *Effects of Atomic Weapons.* We have conducted training courses for civil defense people and we have lent them a considerable number of radiation detection instruments.

Q: If the military continues to block the release of information to the FCDA, which you think is needed for their work, could you and would you go to the President as final arbiter?

A: I don't know of any case where the Department of Defense has blocked the transmittal of information to the FCDA. There are cleared people in the FCDA, and we give them the information they need, but much of it is marked "secret." There have been some differences of opinion between us and the military, but they are differences that involve declassification, not the transmittal of information. It seems to me that the best judge of what declassification actions, if any, should be appealed to higher governmental authority for a civil defense reason, is not the AEC but the FCDA.

Q: Do you, in the light of newer experiences in availability and variety of atomic weapons, consider an acceleration of the industrial dispersal program as important?

A: This question of dispersal is a tremendously complicated one. It has economic and social factors in it, and it has a lot to do with military strategy and defense planning. We are not expert in all of these aspects of the problem. The AEC is the expert in only one thing—what an atomic bomb will do. Taking only this one factor into account, I would say *yes,* industrial dispersal is of the utmost importance. My personal view is that we should have as much dispersal as can be achieved without serious disruption to our economy and way of life. I think this is particularly true as it relates to the location of new industrial facilities. As you may know, we have our own dispersal criteria within the atomic energy industry and we adhere to them. We believe it is the only realistic and sensible way to operate.

Q: Could the AEC do something to focus attention on this neglected area of the American defense effort?

A: We try to do our part by getting out the facts on the effects of atomic weapons, and, as you know, we earlier this year permitted the press and civil defense officials to witness a weapons test in Nevada so they would have some feeling for what these bombs can do. But actually I don't know of anything we can do that would be more eloquent than what has already been done at Hiroshima and Nagasaki.

Atomic Weapons

Q: Is the AEC concerned with the renewal in the American press and public of the "debunking" attitude toward atomic weapons?

A: We don't want to see the A-bomb debunked or written off as just another weapon because that is unrealistic and can only lead to trouble. But we also don't want people to be so afraid of A-bombs that they will panic every time they see a bright light in the sky. What we really want is for people to understand atomic weapons, and to realize that there are big ones and little ones, and to know what to do about it if one goes off somewhere in their vicinity. This pendulum of public and press reactions seems to swing back and forth. Whenever we test a relatively small bomb in Nevada, the debunking experts have their day, and then when we test a big one at Eniwetok the apostles of doom step forward. I sincerely hope that out of all this the average citizen is getting something that enables him to place this whole question of atomic weapons in some sort of perspective.

Q: Do you consider it possible, within the frame of security policies, to set in proper perspective the "tactical bomb" which has become a "baby bomb"—almost a hand grenade—in the eyes of many people including some military analysts?

A: There are baby A-bombs and there are baby elephants. But the baby elephant is still an elephant and he's big, particularly when you place him alongside a chihuahua. And the baby A-bomb is still an A-bomb and it too is big, particularly when you compare the bang it will make with that of a conventional blockbuster. If these things could make only the same bang as an ordinary bomb or shell, what use would there be for them? But there is a use for them, because the destruction they can wreak is many times greater than that of the most powerful conventional bomb.

Q: Could you say something about the mechanism by which decisions concerning the nature and numbers of new atomic weapons are made? (The McMahon Act prescribed a procedure for determining the number of bombs to be built each year, but no variety of atomic weapons was envisaged then.) These decisions might well commit the U.S. to military-political plans. Has the AEC a part in making such decisions, or does it simply report how many explosives it could produce, and orders for so-and-so many weapons of a given type are then given by the military?

A: The major decisions are not reached unilaterally by anybody. The AEC and the Department of Defense play a role, and so does the National Security Council and the President. As you know, the Secretary of State is a member of the National Security Council. I might say this: We have not yet undertaken anything for the military that we have not satisfied ourselves is in accordance with over-all national policy.

Q: Is the AEC concerned with the policies which make it impossible for many foreign scientists to visit the U.S., and scientific meetings to be held here? If so, could the AEC do something to make this concern known?

A: The Commission has always encouraged visits by foreign scientists to the United States when such visits would make a constructive contribution to the atomic energy program and would also be consistent with security requirements. In actual practice, we have had very little difficulty in accomplishing this. You must remember that the government's general policies on such visits affect the Commission

(*Continued on page 274*)

UN Disarmament Commission Proceedings

DAVID R. INGLIS

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LAST fall the General Assembly set up the U.N. Disarmament Commission to consider the combined problem of atomic and conventional disarmament, and the "eyes of the world" have been turned, with varying degrees of hope and despair, on the faltering progress of the meetings that this body has been holding in New York (about once a week on the average) since last February. The ray of hope that shone on the establishment of the Commission, with the Soviet concession to consider "continuous inspection," has not grown brighter. Many words have been said, many clear words of sincere exploration toward agreement, many confused words with propagandistic intent, and some devious words containing veiled suggestions of developing attitudes.

The frustrating Soviet tendency to malign others as a method of avoiding real discussion was so strong, following the precedent established in earlier forums, that it is easy to make the mistake of letting this salient feature eclipse any more specific meaning that might be found in the proceedings. It is better in the short space here available not to try to give an adequate impression of the frustrations, but rather to seek out the significant implications of the meetings. No attempt is here made to report the lengthy discussion of the Soviet refusal to permit investigation of the alleged use of bacteriological warfare in Korea, since this bore only indirectly on the general problem of disarmament with which the Commission is concerned.

Some weeks were spent adopting a work plan. The Soviet suggestion of a plan was the occasion for the first audition in this hall of a record that was to be played many times, as though it constituted everything on the fundamental problem of disarmament planning that the Soviet delegate was permitted to say. It called for consideration of (1) unconditional prohibition of atomic weapons and other weapons of mass destruction and establishment of strict international control, both to come into force simultaneously; (2) one-third reduction of the armed forces of the major powers within a year, and the calling of a world conference to consider further reduction and measures for control; and (3) compulsory submission of full information on armaments.

The French work plan was adopted, calling for consideration of (1) disclosure and verification, (2) regulation of all armaments and armed forces, and (3) procedure and timetable for putting these into effect. A Canadian proposal that the Commission should meet in closed sessions, which might have facilitated useful discussion by minimizing propaganda, failed to pass by one vote, the U.S. and France having joined the USSR in opposing it!

Urgency of Atomic Inventory

Early in the debate the French delegate, Mr. Moch, eloquently emphasized the importance of progress toward agreement on limitation of armaments, particularly atomic armaments. If the present "impasse" were to continue for any length of time, he declared, it was possible that a control system could never be established. He stressed that the difficulties of establishing effective control increased with the growing volume of fissionable material. For this reason it was "urgent to proceed with an atomic inventory," mentioned in the General Assembly resolution.

U.S. Arms Count Proposal

A procedural device to meet as two "committees of the whole" to discuss alternately points (1) and (2) of the work plan failed to help because the Soviet delegate claimed to be unwilling to discuss anything but a whole disarmament plan at once. The specific discussion started with the presentation of the U.S. arms count proposal in the form of a "working paper" entitled "Proposals for Progressive and Continuing Disclosure and Verification of Armed Forces and Armaments," which has appeared and was discussed in the June issue of this *Bulletin*. The U.S. delegate, Mr. Cohen, stressed the tentative nature of the plan, which was designed to serve as a basis for discussion with changes invited; it proposed simultaneous disclosure of conventional and atomic facilities.

The Soviet delegate, Mr. Malik, asked how long the implementation would take, to which Mr. Cohen could at first only reply that it would depend on how the arms count is linked to questions of regulation or "prohibition." (He later estimated that it might take two years.) This seems to suggest that U.S. policy is flexible concerning the combination of the "arms count" plan with a control scheme.

Mr. Malik condemned the proposal as a scheme to get information about the arms of others while withholding information about atomic weapons until the far future. He seemed to imply that it would work only one way, as though, as the British delegate suggested, the USSR considered that it had enough information about others. Malik also ignored the invitation to suggest changes and, when later urged to do so, declared that no change could improve it.

One of his remarks that sounded sensible was: "Without agreement on arms reduction and the prohibition of atomic weapons, no freedom-loving and independent state can agree to the disclosure and verification of data

on its armaments and armed forces." Such a sentence might have served as an introduction to a suggestion that the arms count be combined with some control measures, but it was not so. Instead, the word "prohibition," like "freedom," is probably to be understood here in the special Soviet meaning, in this case "immediate prohibition and elimination," which precludes any realistic gradual approach to complete elimination.

Intentions Beyond the Arms Count

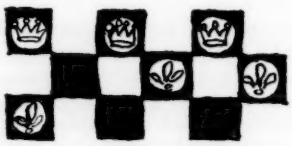
The French delegate, Mr. Moch, was the first to introduce explicitly the possibility of combining "arms count" and "control" arrangements into one agreement, and he suggested "dovetailing" the stages of the two. The U.S. representative agreed that it would be possible to arrange for some stages of limitation to be implemented before the arms count would be completed, but neither he nor the French representative was prepared to go into more detail. In order to try to meet the Soviet objection to so many stages in the "arms count" proposal, the French delegate presented for discussion the bare outline of a modification having only three stages. They were to concern disclosure of (1) volume of armed forces, (2) the organization thereof, and (3) their operational value. A parallel and somewhat similar set of stages was intended in the atomic field, but he did not attempt to describe them. Even in this outline form the modified proposal received the usual spirited Soviet rejection.

The question naturally arose as to what was intended beyond the arms count, and the U.S., United Kingdom, and French representatives made it clear that their governments intended to stand by the "majority plan" for atomic control, which grew out of the Baruch proposal, until some other equally effective plan should be presented. This plan, with its mechanism for international ownership and operation of atomic facilities, has long been anathema to the Soviet representatives, so it is not clear how the Western delegations could have expected to make progress toward agreement merely by supplementing this with the arms count proposal.

Need for Clarification of Soviet Proposals

In the discussion of control plans as distinguished from the "arms count," the Soviet delegate objected to discussing generalities, and insisted that the Soviet proposal, as outlined in the Soviet work plan above, was the only definite control proposal on the agenda and should therefore be discussed. So it was brought up for discussion, and intelligent questions seeking clarification were asked by the French, United Kingdom, and Canadian delegates. It was asked in what sense the prohibition of atomic weapons and the institution of international control should be simultaneous: did it imply merely a broad agreement that a control organ would be set up or that a detailed plan would be written into the decision? Further, what was meant by the Soviet qualification that the international control organ should not be entitled to interfere in the domestic affairs of states: was it meant in the same sense in which the Soviet government considers Western practices in journalism as "criminal interference" with the government? The need for clarification was further emphasized by an analysis of Vishinsky's remarks in Paris a few months earlier.

With the discussion of the Soviet plan thus propitiously started, Mr. Malik weakly complained that the substance of the matter was being drowned in a flood of "irrelevant and artificial" questions. He then claimed that no progress could be made while the U.S. clung to its plan for international ownership instead of control. As the British delegate summed it up, Mr. Malik gave the surprising answer that he would explain what was meant by the Soviet term "inspection on a continuing basis" if the UN majority control plan were abandoned!



Soviet Reply

This and other examples of stalling for time seem merely to have indicated that Mr. Malik was waiting for instructions from home, or for time in which to make old phrases sound new, for a month later, when the agenda had turned to another matter (a report to the General Assembly), he suddenly interrupted with some of the desired answers, fragmentary and obtuse though they were. He said that the system of control proposed by the USSR "provides for broad measures to insure strict international control, namely: investigation of the activity of installations producing atomic raw materials and atomic energy, a check-up of their books, existing stockpiles of atomic raw materials, materials and half-finished products, study of production operations in a scope necessary for the conduct of control over the use of atomic materials and atomic energy, control over the observance of regulations of technological control." Thus, he continued, his government was proposing not only "control as such" but also "technological control" and the right to order installations dealing with atomic materials to adopt certain regulations for technological control over these installations.

The control organ, he went on, would have the right to gather and study data on the production of atomic materials and atomic energy. It would have the right to conduct inspection on a continuing basis and "to conduct special investigations in case of suspicion of a violation of the convention on the prohibition of atomic weapons, etc." (This was mere repetition of a phrase on which clarification had been sought.)

The question put to the Soviet delegation—whether international inspectors of the control organ would have the right to enter Soviet territory and visit Soviet atom installations—was a "ridiculous, silly, and artificial question," Mr. Malik declared. It had been asked only to cast doubt on the Soviet proposals. Those who asked such questions should merely consider whether the activities provided for in the Soviet proposals, such as inspection of atomic installations, of their books and stockpiles, were feasible "without the participation of live persons and without visits to such installations by representatives of the international control organ."

This speech marks a high point in the detail with which a Soviet spokesman has discussed a mechanism for the control of atomic energy, and as such should be suggestive, but in reality it does little more than enumerate some of the aspects of the problem that remain in need of detailed discussion, and some of the terms that need a common definition.

Malik also had something to say about the conventional arms, in rebuttal to the Western claim that the Soviet proposal of a one-third cut in armed forces would leave the USSR and communist China with an enormous lead in that respect. He claimed

that the USSR armed forces, including land armies, air force, and navy, number about 2.5 million men, whereas Western estimates have put this figure at about 4.1 million, to be compared with 3.5 million for the U.S., 1.02 million for the British, 0.89 million for the French and a Western estimate of 4 million for communist China. Thus the Soviet proposal seems to have offered to demobilize fewer men than was at first believed, whatever the actual number may be.

Tripartite Proposals for Numerical Ceilings

In the meantime, in order to define the general goals, the U.S. delegate unsuccessfully sought agreement on six principles of disarmament: (1) that the goal is not to regulate but to prevent war; (2) that states must cooperate to establish an open and substantially disarmed world by (3) reducing armaments to a low level by (4) progressively reducing "permitted armaments" to "fixed maximum levels" and eliminating weapons of mass destruction, (5) establishing effective safeguards, in particular (6) an effective system of international control of atomic energy.

Toward the end of May a proposal was made by France, the United Kingdom, and the U.S., specifying the "fixed maximum levels" of conventional armaments. It was proposed that the U.S., the USSR, and communist China should each retain armed forces numbering 1.5 million men, and France and Britain each about half that number, which would leave the three powers on one side and the two on the other equally balanced in this respect. For France and Britain this would involve practically no reduction. Other powers than these five would have a maximum of 1 per cent of the population. It was indicated that this proposal was tied to the arms count and that other arrangements would have to be made concerning atomic armaments, since they were not covered by this proposal.

In submitting it, the British delegate indicated that it was intended as an improvement from the Western point of view over the Soviet proposal of a uniform one-third reduction, and he remarked that the "plan had been mulled over for several months at high government levels." This remark gives an indication of the rate at which thought is being devoted to these serious but quite preliminary matters. Mr. Malik objected to the proposal on the grounds that it was not a one-third cut in armaments and that it apparently leaves a time lag between decisions on regular disarmament and on the prohibition of atomic weapons.

Proposal to Farm Out Discussions of National "Needs"

On August 12 the same three powers submitted a supplementary proposal suggesting how agreement might be reached on various questions, including the distribution of the allowed forces among various categories of armaments. The awkard-sounding procedure suggested "for the sake of the discussion" emphasizes the prospective difficulty of taking into account the desires of both the large and small powers. It is proposed that first a conference of the big five should essentially take over the job of trying to solve the problems assigned to the present disarmament commission, trying to reach tentative agreement on (1) distribution within the armament categories according to the "needs" of the various powers, within the agreed-upon ceilings, on (2) armaments to go with the armed forces, and finally on (3) the elimination of armaments not permitted, and machinery for atomic control. After such a tentative agreement, the second step would be a set of regional conferences to arrange for detailed balance of these three items according to national needs. The third step would then be the amalgamation of these agreements into a treaty under the U.N.

The talk in this section of a nation's "needs" for armed forces, depending on its responsibilities and commitments, sounds as though it refers to "police" forces which might be independent of other nations' armaments, but the numbers contemplated in the "fixed maximum levels" mentioned above seem instead to envisage a high level of competitive armament. Then too, the proposal of further ponderous machinery for negotiation of a problem on which it appears already enormously difficult to obtain agreement between the two principal contenders makes one wonder whether the small powers would not be glad to adhere to almost any plan agreeable to the major powers if it should really mitigate the threat of atomic war. (At Paris last fall, India and Indonesia professed a willingness so to do.) Ready-made rather than hand-tailored provisions for the national needs might be good enough, and much simpler.

Question of Timing

A part of the proposal coming closer to the actual disarmament problem deals with timing and coordination to ensure balanced reduction of over-all armed strength and to avoid creating or continuing "any disequilibrium of power dangerous to international peace and security." The initial reductions in armed forces and permitted armaments would be started at the same time as initial steps toward elimination of prohibited armaments, with subsequent steps synchronized.

Mr. Malik, among other reactions, welcomed the supplement as having been brought forth by his criticism of the original proposal, showing the usefulness of his criticism. Concerning the crucial question of timing, he asked, whether the new supplementary proposal provided for the adoption of concrete decisions in regard to the reduction of armed forces and armaments simultaneously with the prohibition of the atomic bomb, and the establishment of control of this prohibition. Mr. Cohen replied that, if he understood the question aright, the answer was "yes." But this is about as far as that hopeful beginning of a discussion went.

Lack of Preparation

Later discussion disclosed that the proposal for the big five and regional conferences was not made with the intention of shifting any of the Commission's responsibilities to others. It was felt that, within its "wider task," the Commission could request any of its members and others to explore the possibility of agreement on certain points. The observer, however, is still left with the impression that substantive discussion has been purposely avoided because of a lack of preparation. For example, the Soviet delegate insistently pressed for some indication or rough example of what the sponsoring powers would consider an appropriate breakdown into categories of armaments, and the request was repeatedly avoided by the claim that it should come within the province of the proposed big five conference. Quite apart from the manifest shortcomings of others, our State Department must consider itself remiss for its failure to be ready to give some approximate answer, at least by way of illustration, to this legitimate attempt to enter into discussion, especially in the light of our professed flexible attitude and the preliminary nature of the proposed procedure. Even though

a tentative reply would probably be subjected to immediate misinterpretation, it would seem that gradual progress toward agreement in such a commission cannot be fostered without replies to reasonable questions.

After a final Soviet rejection of all the Western proposals late in August, the meetings were disbanded for September and early in October were last seen going behind closed doors, with Soviet objections still issuing from the crack. The final sessions were to be closed, following a precedent of the Security Council, for the sake of discouraging further protracted debate and for consequent efficiency in the task of adopting a report to the General Assembly, which was to meet in mid-October.

Looking back on this first half year of the meetings, one can see no real progress toward agreement and only a little clarification that goes beyond what was said at Paris last fall. The pace is distressingly slow in the light of the pace of the atomic arms race. Mr. Malik has made it clear that "continuous inspection" would include access of inspectors to declared atomic producing facilities, but it has not been made clear that the Soviet proposals would permit a search of all territory to verify that all producing facilities had been declared. In the debate following the U.S. arms count proposal, the Western delegates have indicated their willingness to "dovetail" steps of control with steps of the arms count, but they have not been willing to give up international ownership of atomic facilities as the fundamental mechanism of control. It is not clear why a decision to give this up has not been reached, since, with the existence of large stockpiles, there is greater uncertainty as to past production than as to immediate future production. Relaxation on this point might significantly reduce Soviet uncooperativeness, as Mr. Malik implied. On the apparently crucial question of the timing of "prohibition," there seems to be some likelihood that a compromise could be reached in which "prohibition," in the sense of "agreement not to be the first to use in war, and to start promptly on stages of control and elimination" of atomic weapons, would be simultaneous with agreement on immediate and continuing arms reduction. At least, some interest in a possibility of this sort seems to have been shown by the Soviet delegate in the type of questions he has asked.

Almost all of the delegates are to be commended for their long patience in enduring diatribe where there should have been deeper discussion. The delegates are to be commended, too, for their attempts to work toward agreement within the apparently rather narrow limitations of discussion permitted by some of their governments. The slow pace of the Commission is apparently to be attributed to an appalling lack of interest on the part of the principal foreign offices of the world, as though the urgent problems of disarmament merit not even a small fraction of the effort being expended on the arms race—which would be made unnecessary by success in the Disarmament Commission. Success of the Disarmament Commission, or of some other instrument of negotiation, once the problems have been thought through, could do what the arms race cannot in securing the future of the nations individually and collectively. At least that last small fraction of the effort, which might have been put on disarmament problems, seems to have been misplaced.

An Interview with Gordon Dean

(*Continued from page 270*)

only indirectly—because of the restrictions already specifically placed on foreign participation in our program by the Atomic Energy Act of 1946.

Exchange of Information with Other Countries

Q: Do you believe that a closer cooperation with other Atlantic Pact nations in atomic matters is desirable and possible without endangering national security?

A: Yes I do, particularly in the case of our traditional atomic energy partners, Britain and Canada, and also Belgium, upon whom we rely for a substantial share of our uranium supply. As you probably know, the Congress recently passed an amendment to the Atomic Energy Act which permits, subject to a number of safeguards, a rather wider interchange of information between us and our foreign friends than has hitherto been the case. We have already entered into one agreement with Canada under this amendment, and we are currently looking into the possibility of exchanges with the other countries where there would be a mutual advantage. We are also assisting Belgium in the training of technicians and in the transmittal of unclassified technical information.

Q: Do you believe that potentially useful information is being withheld from us by England or other nations in reciprocity for our treatment of them?

A: Of course. There are a good many things they are doing that we would like to know more about and we hope that some sort of an agreement can be worked out whereby we can gain access to this information. We would expect, naturally, that any such arrangement would be reciprocal. We must assure ourselves, however, under the law, that our secrets will get the same degree of protection in the other countries with whom we might exchange information as they do within our own program.

International Control of Atomic Energy

Q: Has the AEC an advisory capacity in determining the national policy in disarmament and weapons control plans?

A: Yes; it is mainly a technical one.

Q: Has any advice from the AEC been taken in connection with the new arms count proposals, which substitute reliance on inspection alone for the managerial control required by the Baruch-Acheson plan?

A: Yes, but the new proposals are not quite as you describe them. They are not a substitute for the Baruch plan. They are proposals for steps leading up to the agreement upon and activation of a real control plan. They call for disclosure and verification of all arms, atomic and otherwise, as preliminary steps to the development of a managerial atomic control plan. International control through an international managerial organization still remains the ultimate objective of the United States. Actually, if the Soviet Union will go along on this to the extent of disclosing and permitting verification of its declared atomic energy facilities and weapons stockpiles, I doubt very much if we would have much trouble taking the further step of setting up a real and effective international control plan. I think we should bear in mind, however, that this impasse on atomic energy control is but a symptom—it is not the disease. When the Soviets show they are ready to cure the disease, I believe this symptom will be cleared up automatically.

Private Industry and Atomic Power

The plans to use atomic energy for the production of industrial power have entered a new stage. Four industrial teams, each formed by two private companies, have carried out studies of the feasibility of industrial participation in an atomic power program and have now submitted their reports to the AEC. Although these have not been released for publication in full, the general conclusions of at least two of them have been revealed.[1] *Both suggest further cooperative studies with the AEC, this time on the pilot-plant level, in which part of the necesary capital will be invested by private industry.*

In the papers by Mr. Cisler, of the Detroit Edison Company, and Mr. Putzell, of the Monsanto Chemical Company, printed in this issue, the general ideas of the two plans are outlined. Since both plans contemplate production of plutonium for the government, as an additional source of income to supplement that from the sale of electric power, they could not be put into full-scale operation without an amendment of the provision in the Atomic Energy Act prohibiting private production of fissionable materials.

A number of other questions of great importance and complexity which would be raised by a decision to go ahead with those projects on a full scale, are discussed in the papers by Mr. Dean and Mr. Zuckert, AEC commissioners, and in an interview with Dr. Lawrence Hafstad, director of the AEC's Division of Research and Development, also to be found in this issue.

On April 22, 1952, the AEC announced its decision to go ahead with the proposal of Dow-Detroit Edison, without prejudice to the plans submitted by the other industrial groups. On April, 6, 1952, the AEC announced its readiness to enter into discussion with other similarly organized industrial groups which may want to explore the field, with proposals to be presented before June 1, 1952. On September 14, the AEC announced that six firms had responded; one proposal for a twelve-month's survey from the Pioneer Service and Engineering Company of Chicago and the Foster Wheeler Corporation of New York, has been accepted by the Commission. It was the "only proposal submitted in sufficient detail for thorough evaluation to date."

The secrecy covering some important data (such as the volume and costs of processing the different supplies of raw materials, the present state and the anticipated economy of the breeding process, etc.,) makes intelligent discussion of these questions difficult, but not impossible. Unfortunately, the general atmosphere of secrecy tends to discourage public debate even in the areas where enough information is available. The several articles printed below are intended to stimulate this debate.

[1] A third plan—that of the Commonwealth Edison Company and Public Service Company of Northern Illinois—has been presented before a conference called by the National Industrial Conference Board in New York on October 16–17, too late for inclusion in this issue of the *Bulletin*.

The Prospects for Industry

EDWIN J. PUTZELL, JR.

Secretary, Monsanto Chemical Company

IN SEPTEMBER, 1946, Charles Allen Thomas, now Monsanto's president, told the American Chemical Society of a survey that he and others had just completed for the United Nations Atomic Energy Commission. This study showed that electricity from a nuclear plant could be produced for little more than the cost of producing power from coal-fired generating plants.

In 1950, Dr. Thomas outlined a plan for a plant, producing both power and plutonium, constructed and operated by industry with its own funds. The power would be used or sold by the producing company; the plutonium would be sold to the government at a price that Dr. Thomas believed would be lower than it would cost the government to make plutonium in its own plants.

In mid-1951, the Commission contracted with four industrial groups—one of them a team from Union Electric Company of Missouri and Monsanto—which, at the team's own expense, would investigate the technical and economic feasibility of producing electric power from nuclear energy.

Some have wondered about a chemical company's role in the development of atomic power. There are three major reasons why Monsanto is interested and anxious to participate in the program:

First, the operation of nuclear reactors is essentially one of chemical engineering.

Second, Monsanto uses tremendous quantities of electric power. Last year, our electric power bill for manufacturing operations in the United States alone was over $7,000,000.

Third—and perhaps most important of all—we feel we could produce plutonium at a lower cost to the government than it is produced now. This implies no criticism of the Atomic Energy Commission or of its contractors. We believe the AEC has done—and is doing—a remarkably efficient job. But there is no gainsaying the fact that savings accrue from the techniques and methods of the free-enterprise system. The profit incentives alone give it a definite edge over governmental operation, no matter how efficient the latter may be.

Results of Industry's Survey

A year ago, when we approached this study of the feasibility of a com-

bined plutonium and power producing reactor, there were three kinds of questions—technical, economic, and legislative—that had to be answered.

Monsanto and Union Electric now have been able to give the AEC an only slightly qualified "yes" in answer to the question, "Is such a project technically and economically feasible?" Recently, we reported to the Commission that the investigatory phase is virtually completed; that, in our opinion, now is the time to start the design and then the construction of a pilot plant.

I do not want to misrepresent our position: In terms of full-scale producing units, nuclear-generated electric power is still perhaps four or five years away. But we are ready to commence preliminary work toward a pilot plant.

Under the direction of Drs. Philip N. Powers and C. Rogers McCullough, the Monsanto–Union Electric team reviewed all the suggested approaches to producing electric power from atomic energy. They concluded that there is no *present* possibility of constructing a reactor that would produce power only. The manufacture of plutonium as a co-product of the reactor is necessary at present.

Using the Hanford reactors as a starting point—because more is known of this type than of any other—our team concentrated on changes which were indicated. They concluded that a moderated reactor[1] shows promise as a plutonium and power producer. Similar conclusions were reached by an engineering organization which also has been studying the problem.

Our team is not satisfied that this is the only type of power-producing reactor feasible. They also want to find a type which will produce power alone, without plutonium, and will continue to work toward that end; but it appears that a decade or more of intense research and development lies ahead before such a reactor could become a reality.

Proposed Pilot Plant

As a result of their feasibility studies, Monsanto and Union Electric have proposed that the AEC embark upon the design of a pilot plant reactor as soon as possible. We believe that the government should construct and own this plant, until it is decided whether the present law prohibits private ownership of facilities producing fissionable materials in the amounts which such a pilot plant would make. In the interest of time-saving, and of the efficient use of presently existing facilities and experienced technical manpower, the pilot plant should go forward promptly, under government auspices and with government funds. For our part, we propose to have a full share of responsibility in the design, construction, and operation of this plant, and want to co-operate with the Commission at every step in this program.

We believe that once the pilot plant is completed, and the remaining technical questions answered, private industry will invest its own funds in the construction and operation of a full-scale plant for the production of power and fissionable materials. However, to reach that end, a few changes may have to be made in the Atomic Energy Act.

A New Government-Industry Relationship

While we will be working with the Commission in the construction of the pilot plant, Monsanto and Union Electric would continue the study of other types of reactors. During the last year, we invested a considerable sum in this work; an even larger amount will be spent during the coming year. We have assembled a highly qualified staff of scientists and technologists from our own companies, have hired qualified men to supplement them, have contracted with universities for special studies to be conducted, and generally have availed ourselves of the technology that government research has produced and which the Commission has willingly made available to us and to other industrial study teams.

In the next phase, during pilot plant design and construction and continued longer-range reactor research, a new type of industry-government cooperation will emerge. The government and industry would both be investing money and personnel in pushing forward the atomic power development.

Security and safety regulations concerning personnel and property, would continue to be the primary responsibility of the AEC, as is required by the Atomic Energy Act. At the outset, we realized that paramount security and safety requirements were to remain where the Congress has put them, and we have planned our future operations with that in mind.

In studying the feasibility of the industrial development of atomic power, we have borne in mind that the project will have to compete for capital with other investments open to a businessman. The risk of investing in atomic power development must not be much greater than the normal business risk. That means that the power-plutonium reactor must have a reasonable assurance of a market for its products, at fair prices, for a period long enough to permit the investor to obtain a return of his funds. In normal commercial operations, there may be tens, or hundreds, or thousands of customers; but in the case of plutonium, the government is the sole purchaser. The loss of this customer could have disastrous results.

We plan to explore with the Commission the type and duration of an agreement under which private industry would construct and operate a plutonium-power reactor and would sell plutonium to the government at stated prices.

Another new problem—to which some answers may be obtained from the pilot plant operations—is that of the life span of a plutonium-power reactor. The price of the plant's products will have to be influenced by the rate of its depreciation.

No atomic power development program can hope to succeed without continuing access to the government-owned reactor information and technology. Ever since the creation of the Manhattan District, the government has been—properly so—the exclusive repository of all important technical information in this field. In this connection, let me say that the AEC has been most cooperative in supplying our security-cleared team with the necessary information. This same cooperation, we are sure, will continue as the power program progresses, and will be maintained also in the final stage, when the government will begin purchasing plutonium from the private processor.

While no firm commitment has been made by the AEC that it will design a pilot plant reactor of the recommended type, we are most encouraged by the Commission's reaction to our proposals.

As mentioned earlier, some of the problems to be overcome lie in the legislative or legal sphere. One is the scope of the prohibition, written into the Atomic Energy Act of 1946, of private ownership of facilities for the production of fissionable materials. In the preamble to the law, Congress de-

[1] I.e., a slow-neutron reactor, containing a moderator such as graphite, in contrast to non-moderated "fast-neutron" reactors.

clared the policy of the United States to be aimed at the development and utilization of atomic energy for strengthening free competition in private enterprise, subject only to the paramount object of assuring the common defense and security of the nation. No threat to national security needs to result from private ownership of facilities to produce plutonium and electric power, under security safeguards maintained by the government. Adequate machinery can and should be found to police these private plants.

In proposing world control of atomic energy before the United Nations Organization, Mr. Baruch asked for a commitment that there be free and frequent inspection of all participating nations and their work in this field. If such inspection is workable on a world-wide basis, it assuredly can work with private industry in this country.

Patent Rights

Another problem is the need to protect inventions and original ideas developed in the course of the plutonium-power program. Admittedly, patents and inventions dealing solely with the utilization of atomic energy for military purposes should remain the property of the government. However, to give maximum encouragement to industrial development of atomic power reactors, there should be a modification in the present policy which forbids the granting of patents for any invention or discovery useful solely in the production or utilization of fissionable material. While it is understandable that such a rule was adopted when almost all inventions were obtained at the government's expense, with the approaching possibility of major industrial programs in the field of atomic power, a review of such policy is in order. For example, should not some protection be granted to a company which has, at its own expense and effort, found ways to apply atomic reactors as tools in the chemical manufacturing industry?

Atomic Power and National Defense

Let me comment briefly on the great potential that lies in the production of nuclear-created electric power as a tool of diplomacy in opposing the aggression of totalitarian powers. The atomic power project, while it can be useful in our own country, could be even more helpful in developing the resources—and the defenses—of other free nations of the world, once the enabling legislation is adopted.

Look at England. It is now almost too costly for her to produce electric power from coal mined within her boundaries. At Ruabon, North Wales, Monsanto has a chemical plant, and immediately adjacent to it is a government-owned coal mine. Some of the shafts of that mine are beneath our plant. However, on many occasions since the war, that plant has had to purchase coal in the United States and ship it to England. It was cheaper to purchase the coal in New York, ship it to London and transship it to Ruabon than to purchase the coal from the mine next door. How great, then, must be the range of possible benefits to the British economy, of power produced from atomic energy.

Last week, the Italian consul in St. Louis came to tell me good-by, as he was returning to Rome. The conversations soon got to Italy's present economic and social conditions. The consul stated that in his judgment, most of Italy's problems stem from lack of cheap fuel for the production of capital goods. His country has no coal or oil of its own; the maximum possible utilization of water is in sight, and there is only a limited supply of natural gas in a recently discovered field. In his opinion, the only new possibility in sight is power from atomic energy. It alone has the potential for lifting the Italian industrial economy, and raising the living standards of 48 million people.

Similar possibilities exist in other areas, such as South America, Australia, and Africa. Abundant natural resources lie dormant in many instances because the lack of cheap electric power makes them inaccessible. Many arid regions could be made productive if power were provided to pump the needed water.

There has been much talk of the Point Four Program, which would make American technological advances, and engineering and economic know-how available to other areas of the free world. In the development of nuclear-produced electric power we have the greatest tool for contributing to the economic and social development of other nations. Under controls, such as those outlined in the United Nations atomic control plan, an "Atomic Power Plant—Point Four Program" could result in greater advantages, psychologically and materially, than any other weapon in the struggle against aggression.

Based on a speech given at the Fifth Annual Summer Institute of Atomic Energy, University of Michigan Law School, on June 26, 1952.

Policy Problems in the Development of Civilian Nuclear Power

EUGENE M. ZUCKERT

Member, U.S. Atomic Energy Commission

THE emphasis in the atomic energy program has been on applications for national security with the consequent subordination of civilian uses such as power. Another factor, which has seemed to lessen the emphasis on the power field, is our country's comparatively bountiful supply of low-cost conventional fuels.

But now, even in the six months I have been with the Commission, there is a noticeable quickening of interest in atomic power.

I am not one to name a date, but I will say that we will have one, or perhaps a few, nuclear power plants producing electricity for industry or central station networks sooner than the ten or fifteen-year period we were estimating a short while ago.

There are some who urge that all the United States needs to do is to change the Atomic Energy Act so that the restrictions on the private ownership of reactors and the private acquisition of patent rights are lifted.

Then, the argument runs, industry will really go to town.

Because the Commission is in the process of considering this problem, I am not prepared to give detailed answers. I will state, however, that this seems to me an oversimplification.

I would like to mention some of the questions that seem to demand deep and farsighted consideration.

The Problem of Defense

The first and foremost question is: How do we tie in civilian power with national defense? The requirement of national defense is the first consideration at the Commission. It is the reason for the extensive development of atomic energy today. Had there been no World War II, no need for advanced weapons, the progress made during the last ten years might have been achieved only in small measure.

Does the development of atomic power collide with, or is it consistent with the nation's needs for the common defense and security in the broadest sense? This is a question with many facets. For example: Will developing civilian atomic power divert more fissionable material than prudent from military uses, that is, from use as bombs and as submarine and aircraft fuel? And: Can an atomic plant be built to contribute to both civilian and military objectives?

At the present time we are thinking of atomic power as co-product of plutonium, both coming from atomic reactions taking place in uranium, converting part of it to plutonium, and releasing heat which could be used in generating electric power. If atomic power is to be provided as a co-product, by dual-purpose reactors, the role of the government in buying the plutonium produced will have much to do with success in turning out power at a reasonable cost. Unless the government buys plutonium at prices equivalent to its own production costs, at this stage of development, the cost of generating power might be so prohibitive that no commercial firm would undertake it.

The Demand for Plutonium

Whether or not industry can undertake a greater role in power development, as a by-product of plutonium manufacture, might depend on the assurance of a guaranteed market for plutonium during the next ten, fifteen, or twenty years. Before private investment could be attracted to this field, assurance—based on sound contracts—would have to be furnished that the government would continue to need plutonium.

Such a long-range buying plan should also consider the interest of the taxpayer and fairness to all companies concerned. If the military and civilian uses of plutonium enable us to give only a limited guarantee for a period of years, the question would arise of whether we would be justified in buying plutonium for stockpiling beyond the needs, foreseeable at the time. Otherwise, the number of participants in the program might have to be sharply limited, presenting the problem of how to select companies which would be allowed into the circle.

The problem of purchasing plutonium carries along a companion problem—that of pricing. The price formula should provide a profit incentive covering the entire operation, that is, it should take into account both the plutonium and the power sold, as a package on which the seller could make a profit. But how would the price be worked out to assure adequate incentive without entailing unjustified subsidy of atomic power? Can a system of competition among interested companies be fashioned to strike the appropriate balance of these factors?

There is another possibility. If the day should come, which all of us—no matter how doubting we might be—fervently hope will come, when world peace is a reality, when international control of atomic weapons succeeds, or, at least, when international conditions are more tranquil than they are today, would there be a need for the government to continue buying plutonium?

If the buying of plutonium were stopped, it is easy to imagine the dislocation to civilian industries that would have sprung up around reactor sites to utilize atomic power. With a sudden stop order on plutonium buying, and the resultant sharp increase in the cost of power, what means could be devised to avoid or minimize dislocations?

It may be that such problems as these I have been talking about concerning plutonium will never have to be solved. We may hit upon the development of power at competitive cost from non-plutonium producing reactors, though now it appears that this day is not quite at hand. The first step may be non-plutonium producing power reactors for remote, power-starved areas. Study of the development of atomic energy from 1942 leads me to feel that the strides the engineers and scientists are making are so great that "power only" reactors may be nearer than we dare hope for, even though we are still in the early phases of research and development.

Regardless of the type of reactor that furnishes the power, we will still need answers to a number of other questions.

The Location of Atomic Power Plants

One of them concerns the location of plants.

We are sometimes thought to be too conservative in locating plants because we will not extrapolate on the basis of experiments. I can only say that extrapolation, when hundreds and even thousands of lives may be involved, seems to us a slim reed to lean upon.

It is easy to see how the location of the reactors can influence the cost and availability of atomic power. The problem is to determine the responsibility of the government for establishing criteria governing the locating of privately-operated nuclear power plants, and determine the methods of executing these responsibilities.

Health and Safety

Another question is: What should be the government's responsibility for health and safety within privately-operated atomic plants? The Atomic Energy Commission goes to great effort and expense to protect those who work in the industry. Would private industry be able to devote as much attention to these problems?

Security

The problem of security is always with us, and will be of particular concern when the power reactor also produces plutonium.

Undoubtedly, reactors for producing atomic power will incorporate the latest and best technology. Therefore, these reactors will be prize targets for espionage and sabotage by unfriendly nations. What arrangements could be established to assure adequate protection of private atomic plants in the interest of the national security?

The government takes special care to assure continuity of operations in its atomic plants. What provisions can be adopted to assure such continuity in the private plants? For example, would a special labor-management undertaking be needed?

What provisions can be made to assure that only loyal and reliable employees have access to secret work in private industry's atomic plants? We would not expect the FBI, for example, to turn over its reports to private corporations. How are we to handle the problem of the determination of individuals as good security risks? Such problems of security, so closely related to national defense, clearly call for the careful spelling-out of a partnership between industry and the government.

The Stake of the Taxpayer

One big problem, with its several corollary problems, remains to be mentioned. It relates to the stake of the taxpayer in atomic energy.

With almost ten billion dollars of their money, the American people have built up a gigantic publicly-owned industry. At the present time these taxpayers, through their Defense Department, are also the biggest customers of this industry. When we consider the coming of civilian nuclear power, what are the rights of the people (the taxpayers) as original stockholders, and what are the rights of private enterprise, upon which our whole economy is built?

How are incentives to be provided for private industry, with full recognition of the stake of the taxpayers in the atomic energy activities they have sponsored?

Of course, amendment of the present restrictions on private ownership of reactor facilities and the establishment of equitable patent arrangements are inevitable if private enterprise is to be attracted.

In other words, patent and property provisions must be drawn in such a way that there can be a profit, a competitively attractive profit. In the same pattern, there must be engineering competition between private companies so that industry will make maximum contribution to nuclear power development. It is this competition which will most effectively drive down costs and bring technological advance.

Yet, we must not forget that the atomic energy industry is unique in the history of our industries. Every step—research, development, and production—has been paid for with taxpayers' money; every cent of the cost of the vast capital structure underlying atomic energy has come from the same source.

There can be no doubt of the stake of the taxpayer in patents developed as the result of cost-reimbursement-type contracts at government expense. The question that arises is: At what stage in the cooperative development of atomic power does the private company begin to acquire rights? How do we insure equitable access to the know-how, developed at government expense, which must be the background for many patent developments?

The atomic energy research is so expensive that it is inconceivable that industry could support the research program necessary to achieve continuing progress in the shortest possible time. In view of the inextricable relationship between national security and atomic energy, we must ask: Has government a continuing obligation to assure that broad research activities in the nuclear field are continued at a satisfactory level?

Finally, this new source of energy is one of our great natural resources. As the custodian, the government has a special responsibility, in the words of the Atomic Energy Act, for "the development and utilization of atomic energy toward improving public welfare, and increasing the standard of living." What mechanics are needed to insure that the government will be sufficiently knowledgeable and capable to carry out that responsibility?

Portions of an address before the Chicago Section of the American Chemical Society, September 11, 1952.

Electric Power Systems and Nuclear Power

WALKER L. CISLER

President, The Detroit Edison Company

AT PRESENT, atomic energy activities are consuming the country's resources rather than contributing to them because of the large amounts of electricity, manpower, and materials required in the processes. If atomic energy is to take a sound economic place in the world, this situation must be reversed.

Private capital in all probability would not be interested in plants which consume great quantities of electric power except possibly as operators of AEC-owned facilities. They would be interested in plants producing heat that would be useful in the production of electric power.

What is the specific interest of electric power systems in nuclear power?

We can explain by discussing the joint project of The Dow Chemical Company and The Detroit Edison Company for studying the feasibility of utilizing the heat from nuclear fission. It is interesting to note that both of these companies are large users of fuel. Detroit Edison, for example, in 1951 purchased some 4.5 million tons of coal at a cost of more than $35 million.

America's Fuel Consumption for Generating Electric Power

Before discussing details of the Dow-Edison project, let us examine Figure 1. During 1931, the equivalent of almost 44 million tons of coal were used for power generation. At that time the total generating capability of the interconnected systems of the country was about 33.7 million kilowatts.

By 1951 our nation's capability had been increased to 75.8 million kilowatts, and the amount of fuel required for power generation amounted to the equivalent of 159 million tons of coal. This included 105.7 million tons of solid fuels, about 63.5 million barrels of oil, and some 763.1 trillion cubic feet of gas. And, because the electric power industry is expanding very rapidly, fuel requirements will increase greatly in the years ahead.

If we add to the 75.8 million kilowatts of the interconnected systems the 15 million kilowatts of generating capability in our industrial plants, this country now has nearly 91 million kilowatts of generating capability—al-

	Generating Capacity Millions of Kilowatts			Generation Billions of Kilowatthours			FUEL			
	Thermal	Hydro	Total	Thermal	Hydro	Total	Millions of Tons	Millions of Bbls	Trillions of Cu Ft	Coal Equivalent Million Tons
1931	24.6	9.1	33.7	58.4	29.0	87.4	36.1	7.9	138.4	43.9
1951	56.9	18.9	75.8	271.0	99.7	370.7	105.7	63.5	763.1	159.0
1955	88.0	23.3	113.0	410.0	120.0	530.0	152.0			222.0
1960	117.0	27.0	164.0	550.0	137.0	687.0	202.0			278.0
1965	144.0	31.0	175.0	690.0	154.0	844.0	251.0			334.0
1970	171.0	34.0	205.0	830.0	170.0	1000.0	300.0			390.0

Note - 1931 EEI Statistical Bulletin

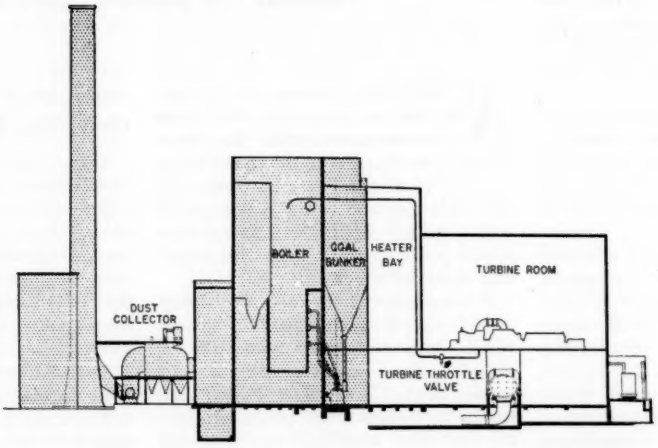
1951 and 1955 Generation from EEI Eleventh Semi-Annual Electric Power Survey
Generating Capacity and Coal Estimated

1960, 1965 and 1970 Estimated Based on statement of Chester Lang, Vice President, General Electric Company, that power consumption will exceed one trillion kilowatthours in 1970

Coal Equivalent for 1970 averages 0.94 lb per kwhr

FIG. 1. The Fuel Consumption for Electric Power Generation. U.S. Electric Power Systems.

ST. CLAIR THERMAL POWER PLANT
Four Units-Total Capability 625,000 KW



	Steam Generation	Electric Generation	Total Plant
Total Cost	$ 48,293,000	$ 50,407,000	$ 98,700,000
Cost per Kw Capability	$ 77.00	$ 81.00	$ 158.00
% of Total Plant	49	51	100
% of Total Company Investment	17*	18*	35*

*These percentages represent the sum of the investments in steam generation facilities, electric generation facilities and power plants respectively, in the four power plants of The Detroit Edison Company, as of June 30, 1951. The new St. Clair Plant is not included.

FIG. 2. Cross Section of Typical Thermal Electric Power Plant. Shaded Area Might Be Replaced by Nuclear Heat Power Reactor.

most 42 per cent of the electric power of the world; 75 per cent of this total capability is in the form of thermal-electric generation and about 25 per cent is in the form of hydro-electric generation. Construction programs will add more than 30 million kilowatts in the next few years. The amount of capital invested in these interconnected power systems today totals about $21 billion.

Eighty per cent of the total generating facilities of the country are private investment owned—systems like the Detroit Edison Company. About 11 per cent are in the systems of the federal government, such as TVA, and about 9 per cent in the systems of publicly owned non-federal agencies.

Now let us look ahead. Figure 1 shows that by 1955 generating capability will have increased to 113 million kilowatts and equivalent coal requirements should be approximately 222 million tons. By 1970—in less than twenty years—annual requirements may be the equivalent of 390 million tons of coal.

One of the best ways to approach the Dow-Edison study was to look at the usual thermal-electric generating station and consider it as two components. The shaded area in Figure 2 represents that part of a normal electric generating station concerned with the production of heat energy. Note where the turbine throttle is indicated in the figure. This is very important because it is at the turbine throttle that the introduction of the heat energy into the turbine for the electric generation occurs.

Included in the shaded area are the coal and ash handling equipment, the boilers, flue dust collectors, and smokestacks—all of the facilities needed to burn coal and deliver steam to the turbine throttle valve. The unshaded portion of the plant includes the equipment and facilities needed to convert the steam received at the turbine throttle valve into electrical energy. These are the turbine generator, condenser, pumps, and numerous other equipment.

How Nuclear Power Reactors Will Affect Costs

Estimates presented in Figure 2 show the cost of the steam generation facilities as $49 million, or $77 per kilowatt of capability. For electric generation the cost is $51 million or $81 per kilowatt.

Present developments show that it may be possible to substitute a nuclear reactor for the steam generation part of a thermal electric generating station. The part of the station that might be eliminated represents a little less than one-half of the station's total cost. The part of the station used entirely for electric generation, costing just over one-half of the total for the station, must remain whether the heat source is from conventional fuels or from a nuclear reactor.

The investment in steam generating facilities of Detroit Edison's four main thermal power plants amounted to 17 per cent of the Company's total investment. The investment in the associated electric generating facilities amounted to 18 per cent of the total investment.

These values are typical for any predominantly thermal system. Since nuclear reactors may be substituted only for the steam generation facilities—accounting for 17 per cent of the total investment in the system—it is obvious that only this comparatively small part of the total system's costs can be influenced by substitution.

We shall now undertake to determine the amount of investment we might be justified in making in a nuclear heat power reactor that would bring energy to the turbine throttle at a cost no greater than the cost of heat from a conventional heat source. There are two columns on Figure 3. The one on the left shows the estimated annual operating costs of supplying heat to the turbine throttle for the conventional plant. The one on the right shows the limit of the investment that could be justified in a reactor, assuming no labor, maintenance, or fuel costs.

For the shaded part of the generating station shown on Figure 2, operating manpower expense is about $180,000, while the operation and maintenance materials and supplies is about $307,000.

Annual Operating Cost St. Clair Thermal Electric Power Plant 625,000 Kw Capability		Justified Investment in Reactor-No Labor, Maintenance, or Fuel Cost (Steam Plant Annual Operating Costs Capitalized at 10%)
$ 180,000	Operating Manpower	$ 1,800,000
307,000	Operating and Maintenance Materials and Supplies	3,070,000
	Investment in Thermal Plant	48,293,000
	Fixed Charges on Investment	
	Depreciation 3 %	
	Interest 5 %	
	Taxes and Insurance 2 %	
4,629,300	10 %	
8,855,000	Fuel Cost (1,232,000 Tons @ $ 7.18)	88,550,000
$ 14,171,300	Total	$ 141,713,000
$ 77	Investment per Kw Capability	$ 227
$ 0.577	Cost per 1,000,000 Btu at Turbine Throttle	$ 0.577

FIG. 3. Calculation of Justified Investment in a Nuclear Heat-Power Reactor and Appurtenances.

The annual fixed charges on the thermal part of the plant, calculated at 10 per cent of the investment, amount to $4,829,300. The fuel costs for that plant will be $8,555,000 (1,232,000 tons of coal at $7.18 a ton). The total annual operating expense of the conventional plant is $14,171,300, and the cost of delivering the heat units to the turbine throttle is 57.7 cents per million Btu's.

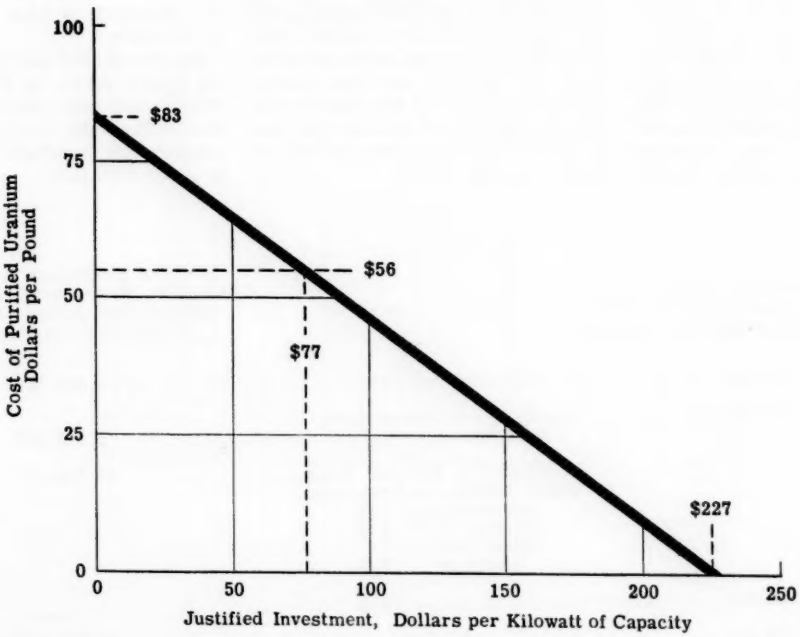
The turbine throttle doesn't care where that heat energy comes from so long as the proper steam conditions are maintained. It can come from gas; it can come from oil or coal; or it can come from fission of atomic fuel.

In the right-hand column the annual operating costs are shown capitalized at 10 per cent. If it is assumed that the nuclear reactor has no operating labor expense, we can afford to invest $1,800,000 for that item alone. For operation and maintenance supplies and materials, we can afford to invest $3,070,000. The annual fixed charges, capitalized at 10 per cent, are $48,293,000. What is normally paid for fuel can be capitalized at $88,550,000. The total of those amounts is $141,713,000—the amount which might justifiably be invested in a nuclear heat power reactor which, at no fuel cost and no operating labor or maintenance expense, would deliver one million Btu's of heat energy at a cost of 57.7 cents. We would thus be justified in investing not more than $227 per kilowatt for a reactor and accompanying equipment capable of supplying steam to generate electric power.

Thus, a comparison of investment costs for two methods of supplying equal heat units to the turbine throttle can be made: in the thermal plant used in this study, $77 per kilowatt; in the atomic plant, $227, under the ideal conditions. If the investment exceeds $227 per kilowatt, the cost of heat at the turbine throttle would be more than by the present conventional means. Incidentally, it is hardly practical to assume that one could build a heat power reactor which would have no fuel costs, no operation and maintenance expenses.

Figure 4 is designed to show how the justified investment in a reactor would change if the ideal condition of no fuel cost could not be realized. Purified uranium is one of several types of fuel that might be used, and under certain circumstances the coal equivalent might be as low as indicated on the chart. If this could be obtained at no cost, then the investment of $227 per kilowatt of reactor capacity would be justified. But with increasing cost of the purified uranium, the justified investment would decrease. When that cost reaches $56 per pound, the justified investment in a nuclear reactor installation would be only $77 per kilowatt, the same as for the conventional thermal plant. If the cost of purified uranium were as much as $83 per pound, no investment at all in a nuclear reactor could be justified.

Based on a speech given at the University of Michigan Law School, June 26, 1952.

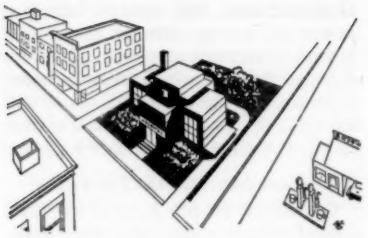


Thermal Electric Plant Assumptions
Total Investment $98,700,000
Annual Fuel Cost $8,855,000 for 1,232,000 Tons Coal
Coal Cost Per Ton $7.18
Heating Value 11,800 BTU per Lb.
Operating Labor and Maintenance-$0.395/Ton Coal

Nuclear Reactor Assumptions
Fuel-Purified Uranium, One Pound is
Equivalent to 7.23 Tons of 11,800 BTU Coal
No Operating Labor, or Maintenance Costs

FIG. 4. Justified Investment in a Nuclear Heat-Power Reactor and Accompanying Equipment. Based on 625,000 kw. Capability, 70 Per Cent Annual Plant Factor and Assuming Various Fuel Costs.

The Government Reactor Program



An Interview with LAWRENCE HAFSTAD

The following interview with Dr. Lawrence Hafstad, director of the AEC's Division of Reactor Development, was conducted by the editor of Chemical and Engineering News, *and appeared in that journal on September 15. We reprint here, with the kind permission of the editor, those portions dealing with the AEC's reactor programs and the role of private industry in the development of atomic power.*

QUESTION: Dr. Kenneth Pitzer, former director of AEC's Division of Research, has stated, "Slowness [in building a power reactor] . . . came . . . from an unwillingness . . . to proceed with [any design] until all of the advisers agreed that this was the best design." . . . Has the program been unduly slow?

MR. HAFSTAD: If you ask me if the reactor development program has moved as rapidly as the Congress, the President, the Commission, the military, the General Manager of the Commission, or I want it to move, the answer is "no." You ask if it has been unduly slow. The answer is "no" to that, too. Though the program may be criticized for other things. I don't see how any program that builds up in three years from approximately $50 million per year to more than $100 million can be called slow. . . .

As to whether the program for the development of atomic power has moved slowly, the answer obviously appears to be "yes," if you use as a yardstick the number of machines we have producing electric power. But if you take into account the fact that the United States is particularly blessed with reserves for cheap conventional power, so that this was not one of our urgent objectives, and if you apply a yardstick of real scientific and engineering accomplishment and measure the filling of the reservoir of knowledge and experience on which the future development of power depends, then I say our program has moved at a constantly increasing rate.

Reactor Development

Q: When did the development of power reactors and power-production reactors begin?

A: Some experimental work was done on power problems in the late stages of the war and early in 1946. One of the earliest projects was one by Dr. Farrington Daniels at Oak Ridge for a power reactor, which was quite a straightforward, direct approach to the problem. It soon became clear, however, that we needed to know a lot more about the behavior of various materials under the unusual conditions of stress which exist in a reactor. . . . This need resulted in the Materials Testing Reactor which went into service this summer at the Testing Station. The MTR is one of our most important resources in this program and provides us with neutron intensities and testing space never before available. We have, of course, used the very fine Canadian reactor at Chalk River, which is a heavy water research reactor based on the original heavy water reactor at Argonne National Laboratory.

The program also called for intensive investigation of the problem of "breeding." . . . Two independent attacks on this important problem, one by Argonne and one by Knolls, were planned at that time.

A third major element in that program was the development of a reactor for submarine propulsion. The Navy was instrumental in starting investigations toward nuclear propulsion at Oak Ridge and at General Electric in Schenectady. In 1948, the Oak Ridge project was transferred to Argonne and became the Submarine Thermal Reactor project. The work at Schenectady eventually expanded into the Submarine Intermediate Reactor project.

Q: At one time the Intermediate Power-Breeder Reactor was part of the reactor program. Among the reasons given by the AEC for this reactor was that the AEC hoped the reactor would lead to production of central station or industrial power in the "distant" future. Yet work on this reactor was deferred in 1950 in favor of work on the Submarine Intermediate Reactor. What was the reason for that deferment?

A: When we first started the Intermediate Power-Breeder Reactor project at Schenectady, we thought we could take a big jump and build a reactor operating on neutrons of intermediate energy levels and at the same time make it breed and produce power. General Electric carried the project far enough along to see that this was a big job to do all at once. In view of the Navy's established requirement for submarine propulsion systems and the darkening international situation, it was decided to make the first intermediate reactor one for submarine propulsion and not attempt in the same experiment to combine breeding with an effort at economical power.

Q: How has this shift affected AEC's contribution to production of central station or industrial power?

A: I doubt if it has affected the power picture much one way or another. Mobile military reactors may make a very substantial contribution to future power reactors of any kind.

Demonstration and use of high-cost power is a step toward lower cost power. The nuclear power plant for a large ship on which Westinghouse is beginning development work will more nearly resemble a central station installation than the submarine plants.

The Part for Atomic Energy

Q: About 80 per cent of the U.S. central station power, excluding electricity generated by firms for internal consumption, is accounted for by private utility companies. Of the $21 billion these companies have invested in their entire system for generation and distribution of power, only 17 per cent is invested in the thermal part—the equipment necessary to convert the heat content of fuel into steam and to deliver the steam to the turbine throttle. This would indicate that in terms of investment the atomic energy part of central station power will not in reality be as large as might be expected?

A: Very definitely. At best, or at most, atomic energy will replace only the firebox and boilers of conventional plants and therefore simply cannot have a revolutionary effect on our industrial economy. This is contrary to the popular misconception that we are seeking a secret process of some kind which will miraculously make electric power free to the consumer.

Q: How large will individual public power plants be?

A: . . . I believe it is safe to say that by standards of experience to date, nuclear power plants will be big. On the other hand, it is entirely possible that some day we may be able to utilize nuclear fuels in what somebody has called "package" power plants of, say, 50,000 kw. of electric generating capacity. This isn't very big, but neither is it small. These are units which might be used in isolated locations where costs of hauling fuel are abnormally large.

The direction of our work now indicates, I believe, that the technical problems related to efficient burn-up of fuel and the cost of processing fuel will weigh on the side of big plants. For purposes of this discussion, I would say a big plant is anything above 250,000 kw. of installed electric generating capacity.

The Price of Atomic Power

Q: Detroit Edison Co. calculates[1] that its 625,000 kw. (installed electrical capacity), coal-fired plant now under construction will deliver one million Btu. to the turbine throttle for 57.7 cents and that the investment per kilowatt of electrical capacity will be $77. The company estimates that the investment for a nuclear power plant would be $277 per kilowatt of electrical capacity to deliver one million Btu. to the throttle for 57.7 cents under the most ideal conditions of "no fuel cost and no operating labor or maintenance expense for the reactor." As the cost of the nuclear fuel increases, the amount available to invest in the reactor diminishes and reaches zero when the cost of the purified uranium fuel becomes $83 per pound. What do the AEC figures show?

A: . . . I am sure Detroit Edison would agree with me, that such figures as those given for the nuclear plant may be very valid today and quite unrealistic tomorrow. However, I think one would be safe in assuming from such figures that there is still a lot of work to be done to make nuclear fuels competitive with chemical fuels.

Q: As a matter of fact, we are not talking today about competitive cost without considerable credit being received from the sale of plutonium, are we?

A: Here we are deeply in the economic side of the problem, I like a statement I saw recently in *Electrical World* to the effect that atomic power can be feasible without being economic. We are trying to be realistic about these things and recommend only such projects as are practical or so close to practical that pilot models can be justified.

Q: John Grebe of Dow Chemical Company has stated that his company wants no part of a program based on military subsidy. The sale of plutonium or U-233 is not inherently restricted to the government, is it?

A: I assume you refer to Mr. Grebe's statements early in his consideration of these problems indicating his interest in a demonstration of the economic practicability of taking power from nuclear reactors without dependence on the sale of its co-product, the fissionable material produced for weapon purposes. He would like to see a demonstration in which the fissionable material produced would be used only as additional fuel for reactors in order to get economic data without the influence of war demands. In that sense, the sale of plutonium or U-233 is not inherently restricted to the government for weapon purposes but could be used to fuel reactors. Of course, you will recall that the law now provides for government ownership of all fissionable materials—uranium-235, uranium-233, and plutonium—and for government licensing and control of all fertile materials—uranium-238 and thorium.

Q: When this power-production program begins and the AEC "buys the plutonium," that is, pays for its manufacture on a unit price basis, how will the price be determined?

A: This is one of the toughest problems we have. I honestly don't know.

Q: Various predictions have been made as to when we will have power from atomic energy:

Ten years will be needed to get the facts (Suits).

There will be no considerable power for twenty years (AEC, 1948).

Full scale production is four to five years away (E. J. Putzell, Monsanto Chemical Co.).

[1] See page 282 of this issue.

Atomic Reactor Costs

Estimated cost of construction of reactors, including preparation of site, architect-engineering costs, fabrication and assembly of core, etc.

Experimental Breeder Reactor	$ 2,805,000
Materials Testing Reactor	18,000,000
Submarine Thermal Reactor (land-based prototype)	26,000,000
Submarine Intermediate Reactor (land-based prototype)	?
Aircraft Reactor Testing Facilities	33,000,000
Production Facilities:	
Savannah River	1,300,000,000
Paducah, Kentucky	473,000,000
Pike County, Ohio	1,200,000,000

What seems to be the reason for such divergent views?

A: As often happens, the different people are really talking about different situations from different points of view and with different personal biases and motivations. The AEC report refers to the over-all power picture of the nation and states that atomic power will not be providing any considerable percentage of the power supply before the expiration of twenty years. The electric power generating capacity of the United States is so enormous that in order to increase it 10 per cent we would have to build a few score of our largest reactors, which would be quite a chore. On the other hand, Putzell was giving the time to complete development and construction of one unit which we could all hope would be economical and practical but on which the risk of failure is still so great that it would have to be underwritten by taxpayers' money.

Q: If conventional fuels are adequate for at least twenty-five years, as the President's Materials Policy Commission reports, why are industrial firms so excited over atomic power at this time?

A: Regardless of the adequacy of the conventional fuel supply, and estimates vary, I believe all of the Commission's contractors and all of the industrial groups studying the possibility of entering the business of trying to make power from nuclear fuels will agree there is a great deal to be gained. Perhaps the gain is, at this time, intangible in some respects; but the advance in technology covers many fields of interest to industry—far beyond the utilization of nuclear fuels. Of course, the use of radioactive and stable isotopes is giving a great impetus to the development of industrial technology of all kinds. However, I believe this increasing interest is mainly a normal and inevitable result of the advance in technology, of the initiative and capability of American industry to capitalize on the advance, and the natural and obvious concern of industry never to be asleep at the switch, especially when the birth of a great new industry appears imminent.

Q: Charles Thomas, president of Monsanto, has said that he envisions atomic energy plants to be best suited for remote western regions. Do you believe this to be the brightest immediate prospect?

A: One of the primary advantages of nuclear fuels is concentration of energy contained in a unit of fuel. Naturally, such a fuel should have first call at any location to which the transportation of conventional fuels is a major fact of cost.

Reactor Technology

Q: Problems to be solved before atomic energy for power becomes a reality have included the following as announced from time to time: remote control, fuel processing, coolants, heat exchange, waste disposal and sanitation, shielding, ore processing, materials of construction. How far along are we toward solving them?

A: I hope you won't think I'm trying to be facetious if I say all of them have been solved in part. There is no single solution to any of them, and all of them are still outstanding.

Q: Which ones will result in the greatest percentage saving in costs when better materials or methods are found?

A: The greatest saving can be made not by nickel-and-dime savings in the current procedure but by the choice of a basic reactor design which eliminates or reduces nearly to zero the present high costs in the supporting operations. This is why we are exploring so many radically different reactor designs so exhaustively. The homogeneous reactor is an example of how a reactor choice might change completely the chemical processing problem.

Q: After an initial, small, power-producing experiment in December 1951, the Experimental Breeder Reactor has been investigating the possibility of breeding for some eight months. What can you tell us as to the status of this experiment?

A: As I indicated at one of the Commission's press conferences last winter, we probably will have very little to say about the results of the breeder experiment. As you know, success in the investigating of breeding is an item of the highest security importance.

Q: How adequate are uranium and thorium reserves?

A: The outlook is more encouraging than it was five years ago. We know there is a lot of uranium in the earth's crust, and we have had increasing success in uncovering new sources of fissionable material.

Q: A high fuel-burnup reactor has been mentioned as a potential solution to fuel problems. What have you learned so far?

A: There is not very much I can give you on this one, except to say that in some types of reactors the extent to which fissionable material is actually burned up, or depleted, is a key factor in determining whether a reactor is to produce power primarily, with fissionable material as its by-product, or fissionable material primarily, with power as its by-product.

In one possible type of high fuel-burnup reactor, plutonium would be

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"The A.F. of L. Views with Alarm"

"Atomic energy itself and technology arising out of nuclear fission must remain in public domain. While development of private investment and enterprise for civilian use of atomic energy should be encouraged, such use of it by private enterprise should be strictly competitive. Private monopoly in any phase or segment of the atomic energy industry is intolerable. Yet even now monopolistic aggregates are already building up, not only around fringes of this public program, but within it. Monopoly of engineering skill and scientific technology is no less dangerous than monopoly of private capital. No private corporation should be permitted to accumulate materials, equipment, or skill of this industry for its own exclusive use or to arrogate to itself the power derived from their exclusive possession."

—Report of the Executive Council of the
AMERICAN FEDERATION OF LABOR
to the Seventy-First Convention, New York
September 15, 1952

produced from U-238, but instead of being removed from the reactor and extracted by chemical processing, it would remain in the reactor and serve as fuel to keep the chain reaction going as long as possible without removal of fuel elements. The less frequent chemical processing would make for economy.

Industrial Participation

Q: In June 1950, Charles Thomas announced his company's interest in participating in the atomic energy program in a role other than that of contractor. Was this the first public evidence of such an interest on the part of industry?

A: I would not say it was the first sign of industrial competitive interest. Dr. Thomas, himself, in the fall of 1946, reported to the American Chemical Society on a survey he and others had made for the United Nations Atomic Energy Committee estimating the cost of nuclear power. There is considerable literature on the economics of nuclear power. Ward F. Davidson, of Consolidated Edison Co., was an early examiner of possibilities; so was J. R. Menke,[2] then of Kellex Co. There were others. The Industrial Advisory Group (Parker Committee) in 1948[3] and the Ad Hoc Advisory Committee on Cooperation between the Electric Power Industry and AEC (Sporn Committee), 1949 to 1951,[4] were additional expressions of industrial interest in atomic energy. I would say the initiative shown by the particular groups which came in on the first round of industrial studies was a culmination rather than a first sign of interest.

Q: Four groups participated in that first study. Were these the only companies which evidenced interest, or were there others which were not included?

A: Two other companies were very much interested in starting such a study at that time. One was Westinghouse, which was already deeply involved in the atomic energy program and was carrying a very heavy load of work. The Commission felt that the Westinghouse engineers and scientists and the company facilities should be equally available to all of the interested concerns and, therefore, asked Westinghouse not to start such a study on an individual company basis at this time. The company very graciously agreed to this and has cooperated in every possible way with the newcomers.

The second company was Consolidated Edison Company of New York. By the time the Consolidated Edison proposal came in, we had already accepted proposals from four teams and felt that we could not efficiently handle any more.

Q: These groups have now submitted their recommendations. The Dow-Detroit Edison group proposes that joint research with AEC be undertaken to develop a dual purpose breeder reactor of advanced design. The study is to be undertaken in AEC and the group's facilities, and the group has indicated that it will spend about $250,000 for its part.

Monsanto-Union Electric, on the other hand, is interested in a short-range development and has proposed design of a pilot plant concurrently with component development and tests. With encouraging results, the pilot plant would be built, if then considered necessary, as a step toward a large plant. Are these proposals contradictory, and must the AEC select one or the other?

A: I would not call the proposals contradictory. They are parallel. They follow different lines of development—one being a line in which we have more experience than the others.

We have decided to go ahead with the Dow-DE group because the data to be developed on the basis of a rather modest expenditure, shared by the companies with the government, are data which we would eventually have to go after anyway. The government's part is about $750,000.

Should there be several contracts along the lines of the one with the Dow-DE group, the AEC may at some point and time have to make a selection among the several proposals before it. The factors that must be weighed cover every possible consideration of national defense and both the short- and long-range contribution of the atomic energy program to the nation's strength. For the most part, these factors are measured in terms of dollars, not always in terms of numbers of dollars alone, but in terms of the ratio of dollars to results. The more industry contributes in money and talent, the more the over-all program will be advanced.

Q: What have the other two groups proposed?

A: The four proposals differ as to the types of reactor designs that would be followed and the financial arrangements. It is planned that the Commission will make public more information soon.

Q: Two of the companies in the first study teams, Monsanto and Dow, are primarily chemical companies, but they are motivated by being rather large consumers of power. Have any other large electricity-consuming industries, such as the aluminum industry, evidenced interest in the program?

A: Yes, of course, the power-consuming industries are interested as customers, but they look to the electricity generating people to carry the ball, and doubtless the utilities which are making these studies have been encouraged to do so by their big customers. I believe it is safe to say that all who are interested in power—whether as producers and sellers of fuel, as manufacturers of equipment, as sellers of power, or as users of power—have shown an interest in the program.

Q: If none of these other large users have taken an active part, however, such as Dow and Monsanto have, chemical companies must have an additional motive for getting in the program?

A: Mr. Putzell, of Monsanto, gives two additional reasons: (1) reactor operation is essentially a matter of chemical engineering, he says; and (2) Monsanto believes that it, a private industry, can produce plutonium at lower cost than the government. To those I would add that chemical companies are logical processors of isolated minerals requiring power for their development.

Q: Information made available to these study teams has been compiled at public expense. How is the AEC making certain that all companies will have equal access to the information available?

A: We are doing everything we can to see that information is made available on an equitable basis. All the industrial participation contractors had access on the same footing to all AEC information on reactor technology. Equal opportunity has been given all

(*Continued on page 292*)

[2] See John R. Menke, "Nuclear Fission as a Source of Power," *Bulletin*, IV (April 1948), 115–21.

[3] Report of this Industrial Advisory Group appeared in the *Bulletin*, V (February 1949), 51–55.

[4] See *Bulletin*, VI (November 1951), 332.

Power Progress Too Slow

KENNETH S. PITZER

Whether the pace of the development of power reactors by the AEC has been fast enough is the subject of much speculation. In the concluding portion of a speech on March 7 before the Southern California Section of the American Chemical Society, Dr. Kenneth Pitzer laid the blame for delays on the procedures of the AEC, charging that the advisory committees were brakes on progress. This portion of his speech is given here. Mr. Pitzer, now dean of the College of Chemistry at the University of California, was director of the AEC's Division of Research from January 1949 to June 1951. Comments on Mr. Pitzer's criticisms by two prominent scientists and a former director of the Research Division of the AEC are printed at the end of this portion of Mr. Pitzer's speech.

I WOULD like to offer some general comments on policy questions and on the effectiveness of our atomic energy effort. The AEC is reasonably efficient by general governmental standards, but I believe we have a right to expect something special in this vital area. Consequently, I hope I can offer some critical comments without having these interpreted as a sweeping condemnation.

There is something wrong when Mr. David E. Lilienthal, the advocate—even the symbol—of public power says, "The time for the first industrial applications of atomic knowledge is overdue—let's end government monopoly and give American competitive industry a chance." I do not agree with many of the details of Mr. Lilienthal's arguments, but I believe he is correct in pointing the finger at monopoly.

In spite of congressional investigations, monopoly tends to be a comfortable position. If unnecessary time is taken to reach a decision, there is no competitor here at home to move into the field ahead of you. If there are unnecessary men employed on a job, it's just a part of the cost—there is no danger of losing money on the job. This lack of real incentive to reduce costs tends always to leave the cost floating around at some level, not disgracefully high, but not necessarily near rock bottom. How can we ever find the true cost of atomic power if the actual costs are inflated?

Of course part of the difficulty is the intrinsic military use of all the principal products of atomic energy at this time. But there are contracting methods which give the contractor an extra profit if he improves efficiency, which could be used more widely than they are. The Congress should encourage the Commission to suggest means by which its degree of monopoly could be reduced and should then cooperate in their implementation.

However, it must be admitted that it will take some time to get away from the AEC monopoly. Can we not make more rapid progress toward both military objectives and useful atomic power in the meantime? I believe we could.

Indecision and Delays

During the war the first reactors and the bombs were actually produced within about three years.

After the successful operation of the Hanford reactors, the additional task of building a power reactor was certainly no more difficult than the original wartime assignment. Yet it was over six years later that the reactor at Idaho first produced a hundred kilowatts last December.

The slowness did not arise from a lack of designs for power reactors which reputable scientists and engineers were willing to build and test. It came rather from an unwillingness of the Commission to proceed with any one of these designs until all of the advisers agreed that this was the best design.

Brakes on Progress

The situation might be likened to an automobile equipped with separate brake levers for each passenger. At every road junction the driver not only had to discuss his preference of route with his riders, but he had to wait until all were convinced, because any one could stop the car. Considering that the power reactor territory is not clearly mapped, it is not surprising that more time was spent stationary than moving.

In my analogy there is one necessary passenger with a brake lever—this is the Commission itself. However, the other passengers are there by the Commission's invitation. They are a multitude of part-time advisory groups and boards. Although the motive is not stated, I presume these boards of noted experts were intended to shield the Commission itself from criticism if some project should fail. But let me give you one example of how such a board tends to operate.

The Extremes of Caution

A reactor is potentially explosive—like a steam boiler or a gas tank—therefore safety considerations are appropriate.

Both the Argonne and Oak Ridge Laboratories are situated on large tracts of land where isolated test sites are available. The reactor designers in the laboratories included all types of safety features in their plans. Nevertheless, it would be entirely reasonable to ask an independent committee to check these designs to see if any errors were made.

But, instead of that, the committee was asked to report whether there was any hazard at all in the operation of the reactors on the sites proposed. Of course, you can always hypothesize that all safety devices fail and that some extreme form of sabotage is committed. Then one can assume the most unfavorable possibility in every subsequent part of the catastrophe.

No reactor has ever exploded, and we are continuously learning how to make even safer types. Still, when a committee is asked, effectively, to take responsibility for reactor safety without any balanced authority over mode of operation or other factors, I do not blame it for pointing out these ridiculously remote risks. Yet the report, once formally issued, led the cautious Commission to hold up the reactor projects until the vast Idaho Proving Ground could be procured.

The Proving Ground is probably a wise investment, because it makes it possible to test the most high-powered and sensitive reactors without the caution that nearby populations would necessitate. But the safer and smaller models could have been built on the original Argonne and Oak Ridge sites without any significant risk and with great savings in both time and money.

Too Many Advisers

The last AEC report shows sixteen of these part-time advisory committees appointed by the Commission in addition to the several statutory committees. Some of these groups are helping to get the job done, but I am afraid far too many of them are actually impeding the work in spite of good intentions. These should either be abolished or asked to report to a subordinate official who can steer their efforts in a constructive direction. There are now too many cooks tasting the broth before it is served; there are too many sources of a high-level negative decision which, once rendered, is then nearly impossible to overcome.

I believe the proper role of the General Advisory Committee has now changed, and there needs to be a corresponding change in membership. We now need men who will specialize in pointing out new fields to explore rather than in double checking decisions in projects already under way.

I am fully aware of the difficulties which have confronted those charged with the atomic energy program in recent years. Much time had to be spent answering ill-informed or prejudiced critics. This criticism tended to make the AEC cautious. However, the production of a force that would deter aggression in Europe has certainly been well worth while. There are equally worth-while goals ahead. I believe there is an opportunity now for a period of greater teamwork and even more rapid progress. I hope it will be realized.

Comments on Mr. Pitzer's Speech

FORMULATING programs and putting programs into operation has been unusually difficult in the Atomic Energy Commission. But this cannot be charged against the General Advisory Committee. On the contrary, in my experience, the members of the General Advisory Committee individually and together have acted with wisdom and fortitude to give the Atomic Energy Commission and the country sound advice on scientific and technical problems.

—J. B. Fisk
Director, Division of Research
USAEC, 1 Feb. 1947–1 Sept. 1948

DEAN Kennth S. Pitzer is to be commended for his straightforward, constructive suggestions regarding the administration of the atomic energy program, particularly with reference to the development of atomic power. When the program was new it was necessary to have advisory committees to help educate the newly appointed commissioners and staff members, but now the whole atomic energy program is well established with experienced personnel. It may well be time to reconsider the place of advisory committees in the plan of organization. If committees are too timid or too uninterested, progress is retarded and the taxpayers do not get full value for the enormous sums appropriated. The costs go on whether the accomplishments are large or small.

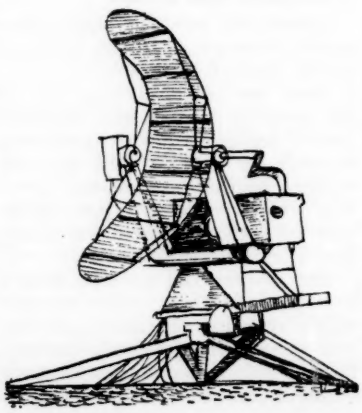
The process of "learning by building," which resulted in such astonishing development in the automobile and airplane industries, might well have had advantages over a philosophy of cautiously testing parts and waiting for agreement among experts on how to build a prototype of the ultimate power reactor. In the absence of actual test data on an operating experimental power unit, no one could possibly speak with authority, and public confidence has suffered in a vascillation between undue optimism and unestablished pessimism.

Certainly those who, like Dr. Pitzer, have served faithfully in responsible government positions do a service in sharing publicly their judgment as to how these government agencies can be made more effective.

—Farrington Daniels
Professor of Physical Chemistry
University of Wisconsin

I HAVE a good deal of sympathy with the views expressed by Dr. Pitzer. On both sides of the Atlantic there are both pessimists and optimists on the production of economical nuclear power. The optimists are usually found amongst the young men working the job. Dr. Pitzer's views on reactor safety are of special interest. We do not have any large expanse of desert in this country and we have had to live close to reactors. By doing so we have acquired considerable confidence in their essential safety. I believe that we can design future reactors to satisfy similar criteria.

—J. D. Cockcroft
Director,
British Atomic Energy Research Establishment,
Harwell



AEC General Advisory Committee Issues Report

The General Advisory Committee to the Atomic Energy Commission has recently issued a report, outlining the procedures it has adopted in the five and one-half years of its existence. We had hoped to include the report in this issue of the *Bulletin*, but have had to postpone its publication until the next issue because of space limitations.

The Atom in National Defense

GORDON DEAN

Chairman, U.S. Atomic Energy Commission

THE military products of the national atomic energy program play a very large and important part in the defense effort of the United States. For a number of years they were about all that stood between us and the formidable Soviet military machine. More recently, some of the other sources of our military strength have been bolstered.

But if anyone concludes that this has resulted in any diminution of the importance of the atom in military affairs, he is mistaken.

The atomic bomb is still the principal instrument by which we may destroy—or at the very least, severely reduce—the ability of an aggressor to make war. In addition, recent technological advancements have begun to find a key place for it in the arsenal of the men whose duty it is—if the need arises—to go out to do battle with other men, on the land, on the sea, and in the air.

Expansion of the Weapons Program

As a result of this development, the Atomic Energy Commission last spring asked for a special appropriation of nearly three billion dollars to increase our capacity to make fissionable material, and therefore our capacity to make weapons. This was over and above the other funds we had already been granted to operate our program as it exists today.

I quote from the statement which I made to the Congress at that time.

"We are well aware of the fact that this is no ordinary request for funds.

"We know that it involves a very large sum of money—the largest single sum ever requested for the national atomic energy program.

"We know, too, that it involves a very large construction effort that will inevitably make heavy demands upon many critical skills and materials that are in short supply.

"And we know that it comes at a time when other defense expenditures are extremely high. . .

"And yet we have concluded that this request must be made. As a matter of fact, we strongly believe—on the basis of all the information we have had—that we would be grossly derelict in the discharge of our responsibility if we failed to make it, and if we failed to make it at this time. . .

"The setting in which this request is made stems from recent revolutionary developments in the field of atomic weapons technology. Through these developments, the whole concept of how atomic weapons can be utilized in warfare has been radically revised.

"No longer are they looked upon only as devices to be used in an 'Hiroshima-type' way against cities and industrial areas. It is now possible to have a complete 'family' of atomic weapons, for use not only by strategic bombers, but also by ground-support aircraft, armies, and navies.

"The Department of Defense is very much aware of this change in concept, and atomic weapons are being incorporated into the operational plans of all three of the armed services.

"This, quite naturally, has greatly increased the demand for atomic weapons—to an entirely different order of magnitude than it was a few years ago.

"It is the purpose of this expansion to meet this new demand, and to meet it as soon as possible.

"We could, of course, meet this demand eventually with the facilities we now have on hand or are building. But we would meet it much later. This new expansion is designed to reach the minimum military stockpile requirements at least four, and possibly five, years earlier than would otherwise be the case."

After a dramatic debate which delayed the adjournment of Congress for several days over the Fourth of July weekend, the expansion program was authorized and we were granted the nearly three billion dollars we needed to get it started.

This program is going forward on schedule. It includes major additions to our plants at Hanford and Oak Ridge and to plants now building at Paducah and in South Carolina. It also includes an entirely new billion-dollar plant to be erected near Portsmouth, Ohio.

But one may well ask, "Why the rush? Why all these new plants and great expenditures just to pick up four years in time?"

The answer is that as of today neither we nor the Soviet Union has all of the bombs that could be used in the event of an all-out war. If our primary objective is to deter war—and that *is* our primary objective—we must hold on to and if possible increase our atomic leadership over the Soviet Union.

The Point of Diminishing Returns

But the current atomic arms race cannot go on forever. Somewhere along the line there is a point where the law of diminishing returns begins to operate. And somewhere, not too far beyond this point, there is another point where we will have acquired all of the weapons we would possibly need to destroy, not only the industrial ability of an aggressor to make war, but also his forces in the field.

When this point is reached, and it is *not* in the *unforeseeable* future, the question arises: "What do we do then?" Do we go on turning out more and more fissionable material and more and more weapons, as we are doing now? Or do we say to ourselves, "Now we have enough; no matter how many bombs our competitor may choose to make, we have enough." I think we should do the latter.

When this point is reached, competition will no longer be one of making weapons and weapons material. It will become, instead, mainly one of designing, developing, manufacturing, and training men to use new and effective

From a speech before the seventy-fifth annual meeting of the American Bar Association at San Francisco on September 17, 1952.

means for delivering weapons and for preventing their delivery against us and our armed forces—competition in the design and development of such items as guided missiles, artillery, supersonic aircraft, electronic devices, radar networks, and the like.

If we can assume that such a point exists, and I am willing to be numbered among those who say it does, some provocative questions are raised. Not the least of these is the question: "What will happen to the atomic energy program of this country?" Will the plants and laboratories be closed down and moss be allowed to collect on the billion-dollar machinery? Or is there some other use of these facilities and the people who have been trained to use them? Cannot most, or at least some, of them be utilized for some constructive purpose?

What should we be doing *now* to get ready for the day when we can go out of the bomb business?

Other situations could conceivably produce an urgent need for an answer. For example, as someone has said, "Suppose peace were to break out tomorrow." This may not be a likely possibility, unfortunately, but it is a possibility nevertheless, and it must be considered.

The obvious answer is to make a determined effort *now* to develop the peaceful uses of atomic energy. This is the answer to the questions about the future, and it is an important and desirable effort to be made anyway, for it is the peaceful promise of atomic energy that has captured the hope and the imagination of the peoples of the world—not its awesome power to destroy.

Prospects for Economical Atomic Power

Let us look, then, into this atomic energy package to see what there is in it for peace. Such a look today would reveal a brighter picture than it would have revealed as recently as a year or even six months ago, particularly in the matter of power. While the bombs and the new plants have been building, and the explosions have been going off in Nevada, there has been progress in the quieter corners of the atomic energy program—progress that has breathed the fresh air of new optimism into the hope for economical atomic power.

A number of factors have contributed to this optimism, and among them I would list these two principal ones:

First, the interest of private industry in atomic energy and particularly the production of power. As many of you doubtless know, we recently had four groups of utility and chemical companies into our program to study the feasibility of economical power production from atomic energy. These groups were greatly interested in the fact that nuclear reactors, in theory, can be built to produce both plutonium and power. Since the government has a demand for plutonium for atomic bombs, and since private industry has a demand for power for commercial use, the simultaneous production of both has an obvious appeal, especially from the standpoint of costs. These four groups of companies were in our program, with our cooperation, for more than six months, and recently they submitted their reports. Not one was pessimistic.

Second, as another reason for the current optimism, I would list the technological progress within our program which has caused a number of scientists to revise substantially downward their earlier estimates of the cost of building a nuclear reactor to produce power.

Let me give just one example. Recently, we completed a new reactor, which is now working successfully. When this reactor was first thought of, it was believed that it would take $50,000,000 to build it. The actual construction cost was $20,000,000, and now I am told by some of our scientists that they feel they could build a somewhat smaller but essentially similar machine, without the costly research features of the original one, for as little as $5,000,000, and possibly even less.

When you get down into this range, the cost of power begins to become interesting—not because it would compete generally with power from coal, oil, gas, and falling water, but because it might begin to become competitive in a few isolated locations where normal power costs are extremely high.

I am not talking here about a reactor suitable for a big central power station, feeding kilowatts by the millions into a utility network. That is what the industrial study groups are pursuing. I am talking about a relatively small machine, that would produce kilowatts numbered in the thousands, but sufficient to perform a useful purpose in undeveloped or underdeveloped areas which are remote from normal sources of power, and which are now either priced out of the power market or can afford only a marginal supply at best.

New Questions of Public Policy

In many ways we are today at a crossroads in the peaceful development of atomic energy, in spite of the heavy weapons load we carry. Many lines of development are reaching crucial points almost simultaneously—the interest of the military in mobile reactors to power submarines, ships, and aircraft; the interest of industry in large-scale production of power concurrently with plutonium; the interest of scientists in small nuclear power plants; and the intensification of the interest of industry, agriculture, medicine, and science in the utilization of radioisotopes.

How much attention should the Commission devote to these developments in the midst of the current expansion program and the atomic arms race? I hold the view that they merit a good deal of attention. I think it is fair to say that in general my colleagues on the Atomic Energy Commission share these views.

So we are going to push forward in this field of peaceful uses. And in doing so we are inevitably going to push into an area where a whole range of questions of basic public policy must be faced up to and resolved.

These questions revolve around the fact that today atomic energy in this country is a government monopoly, and it is a monopoly because that is the law of the land. But if the peaceful uses of atomic energy are to be brought to full flower, is it not true that the government must relinquish at least part of its monopoly? We think it is. But, if so, how much of the monopoly can and should be relinquished? And how can this withdrawal be done neatly and smoothly without disrupting the weapons side of the program and without making room for abuses and inequities? And as it does withdraw, what rights can and should the government leave behind to protect the over-all public interest?

These are important, basic questions of public policy and they will ultimately have to be answered, perhaps by the Congress that will be seated next year.

But since they are public questions, I strongly believe that the public should be thinking seriously about them, for it would be unfortunate indeed if the final judgments were made without the benefit of an enlightened public opinion.

News and Notes

Visa and Passport Problem

The President's Commission on Immigration and Naturalization held a series of ten hearings in various parts of the country during October. At the Boston meeting on October 2, Charles Coryell, secretary of the Federation of American Scientists, drew the Commission's attention to the difficulties experienced by foreign scientists in obtaining visitor's visas to attend scientific meetings in this country and pointed out that the techniques of "the Appeal to the Attorney General" for people who are ruled "inadmissible" are offensive and that few are willing to make such an appeal. He pointed out the absence of non-quota provisions for professional people in the present law and, at the Commission's request, has prepared a written statement on the whole question.

Advance copies of the October issue of the *Bulletin* (devoted to a documented account of American visa policy) were available on October 8, when the Commission met in Chicago. Professors Edward A. Shils, Samuel K. Allison, and Cyril S. Smith testified. When the Commission met in St. Louis on October 11, Dr. Arthur H. Compton, Chancellor of Washington University, presented his views on how the present restrictive practices were harming American science and prestige.

The Commission, created by the President on September 4, will study the McCarran-Walter Immigration Law, which was passed over President Truman's veto, and report to Congress by January 1, 1953.

Review of *Bulletin's* "Cases."—The State Department announced on October 15, two days after the publication of the special issue of the *Bulletin* on American visa policy, that it would review the cases of the twenty-six foreign scientists whose difficulties in obtaining visas to enter the United States were told in the issue.

New Passport Regulations.—The State Department has issued new regulations setting forth in specific terms the grounds for the denial of passports and granting the right of appeal to dissatisfied applicants. Under the new rules an applicant will be given the reasons for the refusal of a passport "as specifically as security limitations permit." He may have a hearing, with counsel, before the Passport Division and, if this is unavailing, may appeal to the newly created Passports Appeals Board.

Membership in organizations designated as communist "action" or communist "front" by the Subversive Activities Control Board constitutes reason for denial of passports, and passports are forbidden to those "... whom there is reason to believe, on the balance of all the evidence, ... are going abroad to engage in activities which will advance the communist movement."

American Developments in Atomic Energy

Ohio Plant.—The Atomic Energy Commission has selected the Goodyear Tire and Rubber Company of Akron, Ohio, as operation contractor for its new gaseous diffusion plant to be built in Pike County, Ohio. The Company will operate in close connection with Union Carbide and Carbon Corporation, which serves in the same capacity at Oak Ridge and at Paducah. On completion of the plant the Goodyear Company will be principal employer there with a permanent working force of about four thousand persons. The facility is expected to cost more than a billion dollars and to be completed in four years.

There will be no new AEC community, similar to the ones at Oak Ridge, Hanford, and Los Alamos.

The Housing and Home Finance Agency will take responsibility for housing the families of married construction workers and will plan for private construction of whatever permanent housing may be needed for operating personnel of the new plant.

New AEC Operations Office.—The Commission has also announced the opening of its ninth operations office, which is to be located in San Francisco, under the direction of John Flaherty, formerly assistant manager in the Chicago Operations Office.

AEC's Committee of Senior Reviewers.—The Commission's Committee of Senior Reviewers—advisors on classification and declassification of information—has been reorganized and increased from four to six members to meet the expanding scope of AEC technical activities. Members of the new committee are Dr. R. H. Christ, of Carbide and Carbon Chemicals Company; Dr. J. R. Richardson, of the University of California; Dr. Thomas B. Drew, Columbia University; Dr. John P. Howe, Knolls Atomic Power Laboratory in Schenectady; Dr. Warren C. Johnson, University of Chicago; and Dr. J. M. B. Kellogg, Los Alamos.

Two members of the old committee had resigned because of the press of other duties. They are Dr. W. F. Libby, University of Chicago, and Dr. R. L. Thornton, University of California.

AEC General Advisory Committee.—Three new members of the AEC General Advisory Committe have been chosen to replace the members whose statutory terms expired this year. They are Dr. Eugene P. Wigner, professor of mathematical physics, Princeton University; Dr. J. C. Warner, president, Carnegie Institute of Technology; and Dr. James B. Fisk, director of physical research, Bell Telephone Laboratories. The retiring members are Dr. J. Robert Oppenheimer, Dr. Lee A. DuBridge, and Dr. James B. Conant.

Appointments.—JOHN O. PASTORE, Republican, of Rhode Island, will succeed the late Senator Brien McMahon as a member of the joint Senate-House Committee on Atomic Energy by appointment of Vice President Alben W. Barkley. The Committee will choose a chairman to replace that post left vacant by Senator McMahon's death July 28.

The Atomic Energy Commission announced last month the appointment of WILLIAM E. LEAHY, president of Columbus University in Washington, D.C., to membership on its Personnel Security Review Board. He will succeed the late Bruce D. Smith who resigned from the board last February.

The Office of Defense Mobilization has appointed A. C. NEWELL, formerly their representative at the Savannah River atomic installation, to supervise activities of the various defense agencies in construction of the atomic energy plant in Pike County, Ohio.

Weapons Tests.—A new series of tests "looking toward the development of atomic weapons" is to be made during the autumn months on Eniwetok Atoll of the Marshall Islands and will be conducted by Joint Task Force 132 and observed only by American government officials and the task force personnel. Speculation that the hydrogen bomb might now be completed and ready for testing has been neither confirmed nor denied by the Department of Defense or the AEC.

Tactical Weapons.—Statements from two official sources were released in early September that atomic weapons are now available for use in the field. General J. Lawton Collins in an interview at Racquencourt, France, September 6, declined to reveal what types of weapons were ready but declared that they would be put into action immediately in the event of war. He said they would be used in support of NATO forces, that they would not immediately decrease the number of necessary divisions for the defense

of Europe, but that they would ultimately do so.

Secretary of the Army Frank Pace stated in Washington on September 7 that we now had atomic artillery, guided missiles, and other ground weapons to add to the total of our power. An "atomic gun," with a caliber of 280 mm. and a range of 20 miles, was demonstrated to reporters on Aberdeen Proving Grounds in September. It has been described as capable of firing atomic shells but not yet used for this purpose.

Atomic Energy Developments Abroad

Great Britain.—On October 3 Britain exploded her first atomic bomb on the Monte Bello Islands, fifty miles off the northwest coast of Australia. London has released no information on the bomb; no U.S. observers were permitted to witness the explosion. It is believed that it was a plutonium bomb similar to those used in the United States tests; that it was a hydrogen bomb has been authoritatively denied. Britain is the third country known to possess atomic weapons; her test came seven years after the first American atomic explosion and three years after the first Russian test.

During the war America and Britain pooled their efforts to produce the first bomb. After the war, America stopped the exchange of weapon information with her wartime partner. Britain has gone ahead on her own; but her financial position has made production slow.

With the British independent success in producing an atomic weapon comes a new demand, from both sides of the Atlantic, for closer cooperation among the allies. The appointment of Sir Roger Makins to succeed Sir Oliver Franks, who has resigned as British Ambassador, may be significant, as Sir Roger is a former chairman of Britain's atomic energy committee.

Mr. Churchill made it clear that he hopes that the British success will induce the U.S. to renew cooperation in her own interest.

France.—A second atomic pile, three hundred times more powerful than the first, has been completed in France and is expected to be inaugurated soon. The plant, about twenty miles southwest of Paris at Saclay is said to be capable of producing 1,500 kilowatts and is expected to turn out 600 grams of plutonium yearly, making the French independent of imported British and American radioactive isotopes for research.

Bacteriological Warfare

The 18th International Red Cross Convention in Toronto unanimously accepted a Polish-sponsored condemnation of germ warfare, urged all governments to ratify the Geneva Convention ban against it, and also passed a resolution asking that all governments concerned with charges of use of bacterial warfare in Korea have the accusations examined on the basis of a common agreement.

On August 15, Benjamin V. Cohen defended the United States government's refusal to ratify the Geneva Convention ban before the UN Disarmament Commission, arguing that to do so in exchange for mere paper promises would give would-be aggressors their own choice of weapons. Jacob Malik, Russian delegate, made a counter-charge that the United States does not want to be tied hand and foot when she decides to use her bacteriological weapons.

Associated Press reported September 15 that a communist Peiping radio had asserted that a six-man international scientific commission had confirmed Russian charges of United States use of BW in Korea. This commission was said to include Joseph Needham, English biochemist; Andrea Andreen of Sweden; Jean Malterre, French physiologist; Oliviero Olivo, Italian zoologist; Samuel B. Pessoa of Brazil; and U. N. Zhukov-Verezhnikov, vice-president of the Soviet Academy of Medicine. The *Bulletin* is asking Professor Needham for a copy of the report, if this assertion is true.

Rosenberg Appeal Denied

The Supreme Court declined to review the case of Julius and Ethel Rosenberg who face the death penalty for passing atomic information to Soviet agents during the last war. This decision was announced on October 13th. Morton Sobell, who was sentenced to thirty years' imprisonment, had also appealed his case to the Supreme Court and was likewise refused a review.

Condon Hearings

The charges of the House Un-American Activities Committee against Dr. Edward U. Condon were at long last given a hearing on September 5 in Chicago. Four years ago the Committee had charged that Dr. Condon was "the weakest link in our atomic security chain." These charges were leaked to the press, and Dr. Condon was not formally invited to clear himself before the Committee until this summer.

At the hearings, which were attended by many scientist friends of Dr. Condon in Chicago, it was claimed that Dr. Condon had expressed some dissatisfaction with the security regulations at the Manhatten Project in a letter to Dr. J. Robert Oppenheimer and had known and given hospitality to several atomic scientists whom the Committee had investigated and who had refused to testify, claiming constitutional privilege. One of Dr. Condon's acquaintances in Washington, Nathan Silvermaster, has been under investigation as a Russian spy. There was no presentation of any evidence other than guilt by association.

The feeling at the end of the hearings was that Dr. Condon was fully vindicated and that it was regrettable he had not been asked to testify at the time the charges were first made.

Foreign Students in U.S.

More than 30,000 foreign students from 126 countries are now attending American colleges and universities according to a report in the Unesco *Newsletter* of August 27. They are enrolled in 1,354 institutions of higher learning. The largest number of students (10,952) is from Asia and the Near East. From Europe there are 7,220; Latin America, 6,802; Canada, 4,232; and Africa, 1,072. Single countries with highest numbers of students are Canada, China, and West Germany.

An Interview with Lawrence Hafstad

(*Continued from page 286*)

qualified firms to take part in this program. With reference to firms getting contracts for various kinds of work, they are given access to the classified information they need to carry on their work.

There is another group which presents a problem in any classified activity—firms which want to examine certain classified activities to find out if they might not be able to render a service. We cannot give clearances for this purpose; there would be too many. It is unfortunate but just one of the problems of classification we are still working on.

Q: What is being done to speed up the declassification of information?

A: Continuing efforts must be carried on to declassify information which is needed by designers and engineers throughout American industry if we are to have a strong atomic energy program. Certainly this is the Commission's position. Declassification goes on all the time, and the amount of material that has already been declassified is tremendous. But we have reached the stage in the declassification process where the additional data desired by industry are definitely in the borderline security area. This presents very difficult questions in making a determination as to when the release of information will aid our own program more than the enemy's. We are aided materially in declassifying information useful to industry by an advisory committee of industrialists, principally representatives of technical societies and publications, who visit laboratories and plants to identify information which would be of value to industry and should be submitted for declassification. The committee also recommends the most appropriate means of publication.

Letters to the Editor

Visa Procedures Show Improvement: Role of Scientific Advisors

DEAR SIR:

The last issue of the *Bulletin of the Atomic Scientists* has described in a very impressive way the effects of the McCarran Acts upon our relations with European scientists, caused by the severe restrictions which they impose upon travel to the United States. It has demonstrated the gravity of the situation and the danger which it presents to our relations with Europe. The State Department was also criticized for its administration of the Acts which aggravated the adverse effects of the restrictive measures.

This summer I had occasion to revisit some of the important research centers in Continental Europe, and I am glad to be able to report some definite improvements in the administration of the law. It seems that the State Department and the consular authorities have now begun to do their best to mitigate some of the ill effects within the framework of the McCarran Acts. Needless to say that the fundamental dangers have not been eliminated nor can they be eliminated by any administrative device.

This observation is based on the following facts. The time for getting a visa is now substantially shorter than it was before. Since about spring of 1952, one can expect a definite answer, yes or no, within not more than two months and sometimes even less. Unfortunately, in many cases the answer is still no. Furthermore, I have heard from many sides that the questions included in the application blanks and also the type of personal questioning at the Embassies have been considerably improved. I have not heard any recent complaints about digging into irrelevant activities of the past and no longer is the candidate subject to questions regarding his political views on current events. It seems that the procedures have gained considerably in dignity.

I have heard these encouraging reports mainly in France and the Scandinavian countries. Especially the French scientists were quite impressed by the improvement, and I have heard many of them crediting the American scientists for having been active in the improvement of the situation. Actually, it seems that the State Department and the consular authorities themselves have taken a great deal of initiative to improve the situation within the narrow limitations of the McCarran Acts.

A great help in this effort is the recent appointment of scientific advisers to the Embassies of important centers of research. This has been done in London, Paris, Stockholm, and Switzerland. This action goes back to a proposal of the State Department's report, *Science and Foreign Relations* (1950) written under the direction of Dr. Lloyd Berkner and has been organized by the scientific adviser to the State Department, Dr. J. Koepfli. The people appointed are all active American scientists from university laboratories. I had occasion to observe their activities in Paris, and it was quite obvious from the reactions of the French scientists that they are doing an extremely useful and very successful job. They established excellent relations, scientific and social, with the scientists of their host countries and have helped considerably in explaining our situation to them and in explaining the situation in the country to the personnel of the Embassies. I am sure that this has helped greatly in the improvement of the situation, and that it will also help in the future.

In spite of these very encouraging developments, one should not forget that the situation as such is still extremely unfavorable. The framework of the McCarran Act does not allow much improvement, even if the State Department and the consular officers continue to take a more realistic attitude. The law still excludes scientists who have had temporary and superficial connections with some political circles that are presently considered as unacceptable. This means that a large number of important foreign scientists still are cut off from any direct personal contact with American science, a situation which is harmful for the progress of science here and abroad, and contrary to our basic philosophy of openness and freedom. The damage done to our international relations, which has been so eloquently demonstrated in last month's *Bulletin*, can be remedied only by thorough revision of the legislation.

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Editor's Note—

A main purpose of the* Bulletin *is to serve as a forum of opinion.

Therefore the* Bulletin *invites reader's comments, not only upon its articles, but upon the current developments in science and society.

GENTLEMEN:

I have just read Jean Rostand's article "Biology and the Burden of Our Times" and find it echoes some of my own thoughts. How easy it would be to shift all responsibility, as did Helen and the other ancient Greeks, to the gods! In rereading *The Odyssey* I note:

> "Presently she (Helen) cast a drug into the wine whereof they drank, a drug to lull all pain and anger, and bring forgetfulness of every sorrow. Whoso should drink a draught thereof, when it is mingled in the bowl, on that day he would let no tear fall down his cheeks, not though his mother and his father died, not though men slew his brother or dear son with the sword before his face, and his own eyes beheld it. Medicines of such virtue and so helpful had the daughter of Zeus. . . ."

Are we responsible for our acts, or are we not, who is to say? Are we an ever changing composite of forces? Perhaps the forces themselves are not "we" at all; but some minute unidentifiable "something" which causes their cohesion may be you and I. I wonder, have any of the Socrates' of the past, so glib in telling us to *know ourselves*, ever accomplished the task themselves?

The term "parthogenesis" is used in M. Rostand's article. Is it now being used instead of "parthenogenesis?"*

I greatly appreciate such provocative articles as this.

Sincerely yours,

MRS. OLIVE OLTCHER

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Pittsburgh 11, Pa.

* Our use of "parthogenesis" for "parthenogenesis" was a typographical error. —ED.

In Our Readers' Judgment:

Every issue of the *Bulletin* has at least one article of importance to the general reader. . . . Its pages carry articles by men whose applied knowledge represents, in many respects, the greatest human power existing on the face of the globe. . . '. For the *Bulletin* is not a technical magazine. It is the medium in which the nuclear scientists can, so to speak, think out loud about what they are doing and why, ask the $64 questions, and answer them if or as they can.

ROLAND SAWYER
The Christian Science Monitor

The Bulletin of the Atomic Scientists is a magazine that can be understood—most of it anyway—by the technically uninformed, or perhaps I should say, by the uninformed technically. . . . If you want some stimulating and provocative reading on this whole subject . . . you will find it in the *Bulletin*.

EDWARD R. MURROW
C.B.S., New York

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DREW PEARSON
Washington, D.C.

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